THE INTELLECTUAL OBSERVER.

JANUARY, 1868.

THE INTELLECTUAL OBSERVER AND "THE STUDENT."

NOTICE TO OUR READERS.

With the issue of this number of the Intellectual Observer the Twelfth Volume of that Work is completed. We advisedly say *Work*, because it was our intention from the beginning not to produce an ephemeral serial, but a publication of permanent value, consisting of articles on a variety of topics of enduring interest, bringing to a focus many scattered rays of knowledge, and offering to the educated classes, wherever the English language is read or spoken, a record of research and discovery in various departments of human inquiry, which we hoped would not be found unworthy of their enlightened support.

From our first issue to the present time, the public have appreciated our labours, and awarded to the Intellectual Observer an amount of favour never before bestowed upon any scientific publication taking the same high ground. In addition to a sale in monthly numbers extending to many thousands, there has been a continued demand for volumes and for sets. The public have thus recognized in the Intellectual Observer the character we desire to claim for it—that of a permanent Work.

This success has necessitated the course we now beg to announce—that of bringing our labours to a definite conclusion, with a view to their immediate resumption in another form. With this number the Intellectual Observer completes and closes its career, and, on the 1st of *next month* (February, 1868), "The Student" will appear as the successor of the Intellectual Observer, continuing the plans carried out in the former publication, with such improvements and additions as the wants of the public and our experience may suggest.

By this arrangement new subscribers will have the advantage of coming in at the beginning of a New Magazine of

Science, Literature, and Art, which will combine all the advantages of our previous publication, with a wider range of topics, a greater variety of illustration, and especial adaptation to the requirements of young men and women standing on the threshold of Intellectual Culture, and needing a friendly hand to guide them through its gates.

For further details of the new arrangements, we respectfully refer our readers to the Prospectuses now issued of "THE STUDENT."

Let not the name offend—the wisest are students from their earliest perceptions to their latest thoughts. Nor must it be supposed that this study and contemplation is without its recreative delight. "The Student's Bower" is no dull abode. To peruse what others have deciphered, or to

> "Read what is still unread
> In the manuscripts of God:"

to hear the music of "Nature, the dear old nurse," when she sings

> "To Him night and day
> The rhymes of the universe;"

these are the privileges of the STUDENT, and, promising that those who best interpret her language shall make its meaning familiar to our readers, whenever she—

> "Sings a more wonderful song,
> Or tells a more marvellous tale,"

we look with hope and confidence to the future, as we invoke a large and liberal amount of public confidence and support.

ON THE PRE-HISTORIC MAMMALIA FOUND ASSOCIATED WITH MAN, IN GREAT BRITAIN.

BY W. BOYD DAWKINS, M.A., F.R.S., F.G.S.*

At the time man first appeared on the earth, the physical conditions obtaining in Western Europe were altogether different from those under which we now live. Britain formed part of the mainland of Europe, and low fertile plains covered with the vegetation peculiar to a moderately severe climate, stretched far away into the Atlantic from the present western coast line. The Thames also, instead of flowing into the German Ocean, joined the Elbe and the Rhine in an estuary opening on the North Sea about the latitude of Berwick. The climate also was very severe, and strongly resembled that of Siberia and North America. One would naturally expect that the animals living on that vast pleistocene continent, under such conditions of life would differ materially from those now living on what are the mere relics of that submerged land. Some of them have utterly disappeared from the face of the earth, such as the sabre-toothed lion, the cave-bear, the Irish elk, the mammoth, *Elephas antiquus*, the hippopotamus, and the woolly rhinoceros and the *Rhinoceros Leptorhinus* of Owen. Others again have departed to northern regions, such as the glutton, the reindeer, the true elk, the musk-sheep, the pouched marmot, and the lemming, while others, such as the cave-lion and cave-hyæna have retired southwards, and taken refuge, the one in Africa, the other in that continent and in Asia. The history of all these animals, and of the race of men associated with them, is, to a certain extent, familiar to most of you. The subject that I have now to bring before you relates to the animals which lived from the disappearance of the post-glacial mammals down to the times of history—a period of uncertain length, to be reckoned certainly by centuries, and probably by tens of thousands of years. The human remains found in Britain, and belonging to the stone and bronze folk, have been diligently looked after by the archæologists and craniologists, but the remains of the animals, carefully sought after in Switzerland and Denmark, have for the most part either been overlooked in this country or confounded with the animals of the preceding epoch. They have been derived from villages and tumuli of unknown antiquity, from refuse heaps and from caverns, which were at once the abodes and burial-places of some early race of man. For this group of animals, and those from alluvia and peat-bogs, I

* "Sur les Mammifères Pre-historiques trouvés avec l'homme dans Grande Bretagne," read at the Congrès Internationale d'Anthropologie et d'Archéologie Pre-historiques in Paris, 1867.

have proposed the term Pre-historic,* because they came into being at a time far beyond the ken of the historian, some of them also long after the close of the post-glacial era. Unfortunately I cannot separate those belonging to the stone folk from those living in the bronze age in Britain. The remains found in tumuli and villages will be first considered.

In 1862 I had the opportunity of examining the remains at Stanlake,† a small hamlet in Berkshire. They were found in and around the circular depressions and trenches which mark the site of a village probably of Keltic age. They consisted of large quantities of the bones, teeth, and skulls of animals that had been used for food, such as *Bos longifrons* in great abundance, the sheep or goat, the horse, red-deer, pig; and there were also the dog, cat, and martin. The metacarpal of a roe-deer had been polished, and exhibited the marks of friction by a string. Along with them were large quantities of flint flakes, rudely chipped lumps of flint and coarse pottery and ashes. There was nothing found to stamp the absolute date of the village, but it probably may have been inhabited at the time of the Roman invasion. In the tumuli of Wiltshire the same group of animals has been met with by Dr. Thurnam, with the exception of the cat and martin. In the same county also the skull of urus has been found underneath a tumulus near Calne,‡ associated with remains of the deer and wild boar, and fragments of pottery ornamented with right lines. It is remarkable as the only authenticated instance of the recurrence of the animal with the remains of man in pre-historic times in Britain.

A vast number of bones have been dredged out of the Thames near Kew Bridge, along with polished stone axes and bronze swords. Their condition proves them to have belonged to animals that were eaten for food, the horse, *Bos longifrons*, pig, sheep, goat, red-deer, and roe-deer. There were dredged up also with them several human skulls that had been gashed and partially cleft, and Roman horse trappings. The river at Kew is shallow, and when we take the number of bronze swords into consideration, some of them even with the metallic end of the scabbard still on the blade, the human skulls and the Roman phaleræ, it is very probable that it was the site of a battle between the Kelts and the Roman legions. All that can be said with reference to the date of the accumulation of bones, is that it was probably anterior to the time of the Romans. A little higher up the river, near the new water-

* "Introd. Pleistocene Mammalia." Part I., 1866. Paleontographical Society.

† "Archæologia," vol. xxxvii. p. 363. "Proceedings of the Society of Antiquaries," vol. iv. p. 93.

‡ "Fossil Skull of Ox." By Henry Woods, A.L.S. 4to. London, 1839.

works, a similar deposit of bones was discovered in the beginning of the year 1867. I found on examination that large oaken piles had been driven into the gravel which anciently formed the bottom of the Thames, and that a quantity of brushwood, principally of willow, had been pressed in between them. On the top was a large quantity of bones, broken more or less for food, and belonging principally to *Bos longifrons*. The whole was covered with alluvium from four to five feet in thickness. It is very probable in this case that the piles are the remains of dwellings somewhat similar to those in the Swiss lakes. There were, however, no fragments of pottery and no implements, the only human remains being some of the long bones.

We will now pass on to the consideration of the pre-historic caverns in Britain which have afforded traces of the abode of man. In 1859 I explored a small cave at the head of Cheddar pass in Somersetshire. The mammalia found in it consisted of the wolf, fox, badger, wild boar, goat, roebuck, *Bos longifrons*, and horse. A human skull, also from this cave, is preserved in the Oxford Museum, which is very well developed, and may have belonged to a person of considerable capacity. During the exploration of caverns in Somersetshire by Mr. Sanford and myself, in 1863,* a second cavern of pre-historic age came before our notice, also in the mountain limestone of the Mendip range in Burrington Combe, about twelve miles from Bristol. It was situated high up in the ravine, and was very nearly blocked up with earth mingled with charcoal. It contained a large quantity of the remains of *Bos longifrons*, red-deer, goat, wolf, fox, badger, rabbit, and hare. In the lower portion of the cave we disinterred fragments of a rude urn of the coarsest black ware, devoid of ornament, and with the rim turned at right angles, together with a piece of bent iron, which more closely resembles those found strengthening the angles of wooden chests in Roman graves on the banks of the Somme than anything else we have seen. The accumulation of bones and charcoal prove that the cave was inhabited by man for some considerable time. The interment is clearly of a later date than the occupation, because it is made in the mass of earth, bones, and charcoal which resulted from the latter. The interval between the two is of doubtful length. In the same year we explored another cavern in the same ravine, which consisted of two large chambers connected together by two passages not more than a few inches high. The natural entrance, but a little larger than a fox-hole, was in the roof of the first chamber, and through this we had to let ourselves

* "Proceedings of the Somersetshire Archæological and Natural History Society." 1864.

down into the cave. Subsequently we blasted a second entrance. The first chamber was at least half full of broken rocks, covered with a mortar-like mass of decomposing stalagmite. Underneath them was a group of four skulls, one of which belonged to the *Bos longifrons*, two others were those of a species of the goat tribe, approaching more closely to the *Aegoceros Caucasica* of Asia, than any other recent species in the oval section of the horncores, in their parallelism to one another, and their slight backward curvature. We have met with a similar form in a refuse heap in Richmond in Yorkshire,* and in the disturbed soil on which London stands, and M. Lartét writes me that he has detected it in a cave in the Pyrenees. In the absence, however, of the necessary materials for comparison from the museums of London, Oxford, and Paris, I do not feel justified in proposing a new specific name. The fourth skull belonged to the pig, and had a round hole in the frontals rather larger than a florin, which had the appearance of being made by human hands.

The presence of the lower jaws with the skulls indicates that they were deposited in the cavern while the ligaments still bound them together. They were all more or less covered with decaying stalagmite. The outer chamber was remarkable for the absence of earth of any kind, except underneath the hole in the roof, where there was a very little; while the inner one, running in the same slope, has its lower end entirely blocked up by a fine red earth, deposited by a stream which flows during heavy rains. Between the stones on the floor were numerous bones and teeth of wolf, fox, mole, arvicola, badger, bat, along with a metacarpal of red-deer and the remains of birds. How the animal remains were introduced, for they exhibit no marks of gnawing, and there are no fragments of charcoal in the cave, or any other traces of man, is altogether a matter of conjecture: but the fact of finding the skulls in one group, coupled with the presence of the hole in the frontal of the pig, leads us to believe that they have been introduced by the hand of man. The entrance was far too small to admit of an ox falling into the cave by accident, and scarcely large enough for a goat or deer to squeeze themselves through; had they been brought in by wolf or fox they would have exhibited marks of teeth.

In 1863 Mr. James Parker explored a cave in the limestone cliffs at Uphill, near Weston-super-Mare, and obtained human skulls and bones, along with rude pottery and charcoal. I have determined the presence of the following animals:—the wild cat, wolf, fox, badger, *Bos longifrons*, pig, red-deer, dog, and water-rat. Most of the remains belong to young

* "Quarterly Geological Journal." November, 1865.

animals, and some are gnawed by dogs, wolves, or foxes. The Heatheryburn cave, in Yorkshire, explored by Mr. John Elliot in 1862,* yielded, besides the remains of man, those of the otter, badger, goat, roe-deer, hog, and water-rat.

In the following table I have arranged the animals found associated with man with those found in the most modern of all the stratified deposits, the peat and alluvium, classing with the latter all those animals now living in Britain which have been found in pleistocene deposits, and which also must have lived, therefore, in the pre-historic period. I have also added a list of the animals living in Britain while it was a Roman colony and those alive now.

TABLE OF BRITISH PRE-HISTORIC MAMMALIA.

	Animals found with man in caves and river deposits.	Animals in peat-bogs & alluvium.	Animals of the Roman period.	Animals now living.
Homo. L.	•	•	•	•
Rhinolophus ferrum equinum. Leach	•		•	•
Vespertillio noctula. Schret		•	•	•
Talpa Europea. L.	•		•	•
Sorex vulgaris. L.		•	•	•
Felis catus ferus. L.	•	•	•	•
Canis familiaris. L.	•	•	•	•
Canis vulpes. L.	•	•	•	•
Canis lupus. L.	•	•	•	
Mustela ermimea. L.				•
Mustela martes. L.	•			•
Mustela putorius. L.				•
Lutra vulgaris. Erxl.	•	•		•
Meles taxus. L.	•	•		•
Ursus arctos. L.		•	•	
Mus musculus. L.			•	•
Castor fiber. L.		•		
Arvicola amphibia. Desm.	•	•	•	•
Arvicola pratensis. Bell.				•
Arvicola agrestis. Flem.				•
Lepus timidus. Erxl.	•	•	•	•
Lepus cuniculus. Pall.	•	•	•	•
Equus caballus. L.	•	•	•	•
Alces malchis. Gray		•		
Megaceros Hibernicus. Owen.		•		
Cervus tarandus. L.		•		
Cervus elaphus. L.	•	•	•	•
Cervus capreolus. L.	•	•	•	•
Ovis aries. L.		•	•	•
Capra aegagrus. L.	•	•	•	•
Capra hircus. L.	•	•	•	•
Bos longifrons. L.	•	•	•	•
Bos urus. Plin.	•	•		
Sus scrofa. L.	•	•	•	

* "Geologist's Magazine." 1862.

I have chosen these caverns as representing the pre-historic fauna of Great Britain. I might have quoted others, such as Kent's Hole, which, having been open during pleistocene and pre-historic times, contains the animals that were then alive, the former at a lower level than the latter; or the Paviland Cave, described by Dr. Buckland, in which the remains of both periods were mixed. I have, however, given a sufficient number of examples to prove how far the pre-historic differed from the post-glacial fauna. These pre-historic mammalia, associated with the remains of man, are also found along with others in the peat-bogs, so that by putting the two groups together we can form an adequate idea of the entire group of animals that inhabited Britain from the disappearance of the post-glacial mammals down to the time of the Roman invasion.

The correspondence of the animals found with man with those taken from the peat-bog and alluvium, and from certain of the more modern caverns, proves that geologically they belong to the same pre-historic epoch. The cave-bear, cave-lion, and cave-hyæna had vanished away, along with the whole group of pachyderms, and of all the extinct animals, but one, the Irish elk, was still surviving. This animal, indeed, is much rarer in England than in Ireland, in which latter country it seems to have lingered after its extinction in the former. According to some of the Irish *savants* it was destroyed by the hand of man. The reindeer still lived on; and its presence proves that the pre-historic climate was more severe in Britain than that under which we now live. As the pre-historic is remarkable for the absence of many of the animals of the preceding period, so is it characterized by the presence of others of a totally distinct character. The sheep, the goat, and the *Bos longifrons* appear for the first time; they are widely spread through and highly characteristic of all the deposits. With reference to the latter of these animals I am obliged to differ from the views of Professor Owen, who considers that it is also of post-glacial age. An analysis, however, of all the evidence that there is upon the subject, compels me to believe that the animal has not yet been found in any deposit of that age in Britain.* Before the invasion of the Romans it was kept in great herds by the pre-historic folk, and is found universally in their tumuli and places of habitation. During the Roman occupation it was not supplanted by any other breed of oxen, as Professor Owen suggests, for its broken bones, teeth, and horncores in the refuse heaps of every Roman town and station in Britian, prove that it alone of the oxen, was the food of the provincials. On the landing of the Saxons it disappeared

* "Quart. Geol. Journal." 1867. Brit. Foss. Oxen, Part. ii.

from the portion of the country conquered by them, and now lives in the smaller breeds of Wales and Scotland, where the Romanised Kelts took refuge.

About that time also it was supplanted by a larger breed probably brought over from Friesland, the home of the Saxon invader. Whence the sheep and goat and *Bos longifrons* came is a question I will not dare to enter upon; but all of them appear simultaneously in Britain, and all are associated with man. It seems to be highly probable that they were introduced by him into our island. The true elk was very rare, and has left its remains only in one place—in Newcastle in a subturbary deposit. The red-deer had vastly increased in numbers since the post-glacial epoch, and very nearly replaced the rein-deer. Its remains, however, show the effect that a more limited range had on the development of the antlers. In post-glacial times, while England formed part of the mainland of Europe, they were very large; in pre-historic times after Britain became insulated they were smaller. A decrease of size is also noticeable in those used for food in the time of the Romans, while a minimum is reached in those which are now living in certain restricted parts of England and Scotland. The wolf and fox were very abundant, but the brown bear was by no means common.

We will now pass on to the comparison of the pre-historic animals with those living in Britain at the time it was subject to the Roman power, and with those which are living at the present day. The Irish and the true elk had disappeared from Britain before the landing of the Roman legions; with these exceptions all the animals still lived on. To the Romans we are probably indebted for a new species of deer, the fallow-deer; for it has never been found in any post-glacial or pre-historic deposit, while in refuse heaps of Roman age it is by no means uncommon. At all events its presence in Britain dates from the arrival of the Romans. After this time in proportion as civilization increased on the haunts of the wild animals, they disappeared one by one from before the face of man. The last historical notice we have of the beaver is that afforded by Geraldus Cambrensis in the year 1188, when he met with it in the river Teivy, in Cardiganshire, on his tour through Wales to collect volunteers for the first Crusade. The brown bear became extinct in the year 1057, if there be any truth in a legend of the Gordon family in Scotland. The wolf, which was sufficiently abundant in Sussex to eat up the corpses of the Saxons left on the field of Hastings by Duke William

> "Vermibus atque lupis avibus canibusque voranda
> Desert Anglorum corpora strata solo,"

lingered on in England until 1306, in Scotland until 1680, and

in Ireland, protected by the uncultivated wilds and the misrule of the country until the year 1710.

In this outline of the pre-historic animals associated with man, I have attempted to prove that the animals of the neolithic and bronze ages in Britain are identical with those found in peat-bogs and alluvia, and that the whole group so constituted differs totally from the post-glacial group of animals. And I have striven to show their relation to the animals now living in Britain. Their comparison with the pre-historic fauna of the Swiss lakes, or that of Scandinavia, Germany, France, and Italy, I must leave to the *savants* of those countries. The modification of that fauna I have shown to be the result of man's influence, and I cannot help believing that the disappearance of the larger animals associated with man in post-glacial times, is in a measure owing to the same cause, as well as to climatal or geographical change. With the larger carnivores man must have waged a war of extermination; while the larger ruminants on which he fed must have found the difficulty of concealment increase in proportion to their size. There is a great gulf fixed, so to speak, representing an inconceivable length of time between the post-glacial and pre-historic periods; and the fauna of Europe, as we have it now, dates from the latter epoch. In Britain, of course, insulated from the mainland of Europe, several animals probably introduced into Europe after that insulation, have not been found, such as the chamois and bouquetin. Had Britain been united to France during the rein-deer epoch, we might have expected to find the remains of those animals.

ELECTRICAL COUNTRIES.

BY M. J. FOURNET.*

(Continued from our September Number.)

In a preceding article upon electrical countries, I especially directed my investigations to remote regions. It now remains, therefore, to concentrate the field of these researches, and to remark that in the mountains of the basin of the Rhone, and those in connection with them, there are some places which are distinguished by electrical discharges of a very remarkable intensity, whilst up to the present time the most absolute silence reigns in others, notwithstanding the apparent identity of surfaces. I hope that the details which follow may excite some attention in observers so that at last some meteorological law may be established. Leaving, therefore, for the present, the details already mentioned by M. Arago, I shall first consider that which concerns the Alpine and Jurassic group, and afterwards return to the most western parts of our country.

Alpine Electricity.

1. *Illumination of the rocks of Mont Blanc.*

A. During the night of the 11th of August, 1854, Mr. Blackwell being stationed on the Grands Mulets (altitude 3455 mètres), the guide, F. Le Couttet, went out of the cabin about 11 o'clock at night, and saw the crests of these mountains all on fire. He made this circumstance immediately known to his companions, they all wished to be assured as to the fact, and they saw that by an effect of electricity produced by the tempest, each one of the adjacent rocky projections appeared illuminated. Their clothes were literally covered with sparks, and when they raised their arms their fingers became phosphorescent.

At the same hour we had at Lyons rather a violent shower with thunder, from the south-west, and the whole of the day had been very stormy.

According to information, for which I am indebted to M. V. Payot, a naturalist universally known, the guide, Couttet, of Chamounix, at the time of his ascent of Mont Blanc the 25th of August, 1841, with M. Chénal, was surprised by a storm on the Grands Mulets which placed them in actual danger on account of the thunder and lightning which surrounded them without intermission. All the stones around them had

* Translated from the "Comptes Rendus."

their electrical sparks, and yet the summit of Mont Blanc as well as the sky were perfectly serene.

2. *Electricity on the Breven.*—In 1767, during very stormy weather, De Saussure, Jalabert, and Pictet were on the Breven (altitude 2500 mètres). There they had only to raise a hand and to extend a finger to feel a kind of pricking at the extremity. This remark, first made by Pictet, was soon followed by another, that as the sensation became more apparent it was accompanied with a kind of whistling. Jalabert, whose hat was trimmed with gold lace, heard a fearful buzzing round his head. They drew the sparks from the button of his hat as well as from the ferrule of his cane. At last the storm was so violent in the cloud which was in the same plane with their heads, that they were obliged to descend from the summit to 20 or 24 mètres lower, where they no longer felt the electrical influences.

3. *Electricity of the snow lying on the soil of the Jungfrau.*—Snow lying on the ground, does not prevent these manifestations; this fact results from the following details. On the 10th of July, 1863, Mr. Watson, accompanied by several other tourists and guides visited the summit of the Jungfrau. The morning was very fine, but on approaching the summit they perceived large clouds piled upon it, and when they had almost reached it, they were assailed by a tremendous puff of wind accompanied with hail. After some minutes they were obliged to make a retreat, and during their descent the snow continued to fall in such a quantity that the little troop, mistaking the direction, travelled for some time in the Latoch-Sittel. They had scarcely perceived their error when they heard a violent clap of thunder, and soon afterwards Mr. Watson heard a kind of whistling which proceeded from his stick. This noise resembled that which a kettle makes when the water boils briskly. They halted and remarked that their sticks, as well as the hatchets with which each was provided, produced a similar sound. These objects did not discontinue their singular whistling even when one end was placed in the snow. Presently one of the guides took off his hat, exclaiming that his head was burning. His hair literally stood on end like that of a person who had been electrified under the influence of a very powerful machine, and all experienced a sensation of pricking and heat in their faces and other parts of the body. Mr. Watson's hair was straight and stiff, a veil which was round another traveller's hat was lifted vertically, and they heard the electrical whistling at the end of their fingers when moved in the air. Even the snow emitted a sound analagous to that which is produced by a sharp hail-storm. There was not, however, any appearance of light, which must have been the case

had it been night. Other claps of thunder suddenly stopped these phenomena, which recommenced, however, before even the grumbling of the clap had been echoed through the mountains. They all experienced an electrical shock, more or less violent, in several parts; Mr. Watson's right arm was paralysed for several minutes till one of the guides pinched it violently with his hand; but he felt a pain in his shoulder for several hours. At last, about half-past twelve o'clock, the clouds dispersed and these effects disappeared, after having been felt for about twenty-five minutes. At Lyons a brisk north wind completely neutralized these stormy manifestations.

4. *Electricity of the Piz Surley.*—A little more to the east are the Grisons which touch Italy, concerning which M. H. de Saussure, whose observations made in Mexico I have already mentioned, has just forwarded to me the following note :—

"The 22nd of June 1865, setting out from Saint Moritz (Grisons) I ascended the Piz Surley, a granitic mountain whose summit, more or less conical, rises to the height of 2300 mètres. During the preceding days the north wind had persistently prevailed; it became variable on the 22nd, and the sky was covered with wandering clouds. Towards noon, these vapours increased, reuniting above the highest, and in other directions keeping high enough not to hide the greater part of the summits of the Engadine, upon which local showers soon fell.

"Their appearance of *dusty vapours* half transparent caused us to think that it was only a shower of hail and snow or sleet.

"About one o'clock at night we were overtaken by a fine sleet, thinly scattered, while similar showers of hail enveloped the greater number of the rocky peaks, such as the Pic Ot, Pic Julier, Pic Languard, and the snowy summits of the Bernina: whilst a violent shower of rain fell in the valley of Saint Moritz.

"The cold increased, and at half past one o'clock P.M., having arrived at the summit of the Piz Surley, the fall of sleet becoming heavier, we prepared to take our repast, near a pyramid of dry stones, which crown the summit. Whilst resting my cane against this construction, I experienced a violent pain in my back, at the left shoulder, which resembled that which would be produced by slowly thrusting a pin into the flesh, and in taking away my hand without finding anything, I felt a similar prick in my right shoulder. Then supposing that my linen overcoat contained some pins, I threw it of; but instead of finding any alleviation, my pains increased, stretching across my back from one shoulder to the other, accompanied by a sensation of tickling, and painful stinging, like that which might be produced by a wasp or some other insect in my clothes riddling me with pricks.

Taking off a second coat I did not discover anything which could have wounded me, while the pain assumed the character of a burn. Without reflecting, I fancied my woollen shirt had taken fire and was going to undress myself completely when our attention was drawn to a noise which reminded us of the humming of wasps. It was produced by our sticks which sang loudly and resembled the noise of a kettle when the water is on the point of boiling; this lasted, perhaps, about twenty minutes. . . . Some moments after, I felt my hair and my beard stand on end, which produced upon me a similar sensation to that which results from a dry razor being passed over stiff hair. A young man, who accompanied me, exclaimed that he felt all the hairs of his moustache growing, and that from the top of his ears there were strong currents. . . . A clap of distant thunder towards the west warned us that it was time to quit the summit, and we descended rapidly for about a hundred mètres. Our sticks vibrated less and less as we descended, and we stopped when the sound had become sufficiently weak, only to be heard by putting our ears close to them. The pain in my back had ceased with the few first steps of descent, but I still retained a slight sensation of it. A second clap of thunder, ten minutes after the first was heard in the west over a considerable distance, and this was the last. There was not any lightning, and half an hour after we left the summit the sleet had ceased and the clouds dispersed. At half-past 2 o'clock P.M. we again reached the culminating point of the Piz de Surley to look for the sun. The same day there was a violent storm in the Bernese Alps, where an English lady was struck by lightning.

"After all, we considered that these phenomena must have extended to all the high rocky points of the Grisons, even to the horizon where there were several stony summits, like that on which we were, enveloped by whirlwinds of sleet, while the high snowy points of the Bernina seemed to have been exempt, notwithstanding the scattered clouds which surrounded them. . . . . On a previous occasion at Nevado de Toluca I had been present at scenes of the same kind, but much more severe, on account of its tropical situation and its height of 4548 mètres.

"However, in bringing together different observations, many points in common can be distinguished amongst them, viz., 1st. The flow of electricity from the culminating rocks is produced under a stormy sky covered with low clouds, enveloping the summits or passing at a very little distance above them, but without there being any electrical discharges in the neighbourhood of the place where the continual flow is manifested.

"2nd. In each of the cases observed the summit of the

mountain was enveloped in a shower of sleet, from which it might be inferred that the continual flow of electricity from the ground towards the clouds helped in a great degree to their formation. Thus, during the observation of the 22nd of June, 1865, in particular, all the rocky points were under the same meteorological conditions, while the valleys situated between the points received violent showers of rain.

"However we must take into account the higher temperature of the hollows, where sleet about to fall turns into rain. M. de Charpentier long ago pointed out the importance of this fact, and with sleet or snow, the results must be the same.

"ELECTRICITY OF THE JURA.

"5. *Electricity of meadows near Courtavon.*

"An instance of *meadow lightning* has been observed in the neighbourhood of Porentury, at the foot of the Jura and near Courtavon. About 100 mètres above the valley, stands the ancient castle of Morimont, the restoration of which has been entrusted to the Engineer of the mines, Quiquerez de Délémont, a man well-known by his splendid mining and archæological works. Being engaged with directing his workmen, on the 26th of August, 1865, he was overtaken by two successive storms between nine and twelve o'clock. At three o'clock in the afternoon there was a third, when the clouds were very low down. Electricity was then exhibited in a frightful manner over the whole extent of the adjacent meadows; sparks succeeded each other in rapid luminous trains passing over the grass instead of through the air. The general noise was such that the individual cracklings were not distinguished. It did not rain; but the observers were almost in the clouds and were all drenched with the morning showers.

"During this journey, three or four leagues east of Morimont and on the continuation of the Jura chain, but a few minutes later, lightning was remarked which ran over the fields and meadows, as if the earth was all on fire. Thus M. Quiquerez was not the only one who observed this phenomenon, and I may add that the storms extended to Lyons.

"6. *Electricity of the lakes near Neufchâtel.*

"Discharges of the same kind are manifested on lakes, and M. Arago has already noticed the fact in a pond at Parthenay (Vendée) in his *Notice sur le tonnere*, page 371.

"The Swiss Société d'Histoire saw an example, on the 2nd of August, 1850, while sailing on the lake of Moret about eight or nine o'clock at night. They then heard thunder at Montbéliard, Châlon, and Bourg.

"Also on the lake of Bienne, the boatmen of Nidau thought on one occasion that they were crossing a sheet of fire."

NOTES ON THE CRUSTACEAN FAUNA OF THE ENGLISH LAKES.

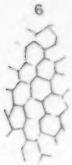
BY GEORGE STEWARDSON BRADY, M.R.C.S., C.M.Z.S.

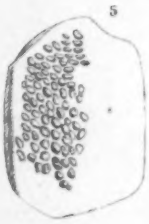
(With a Plate.)

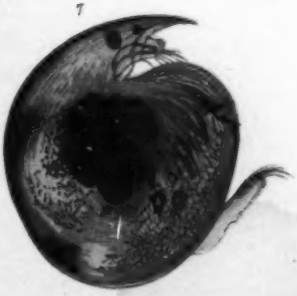
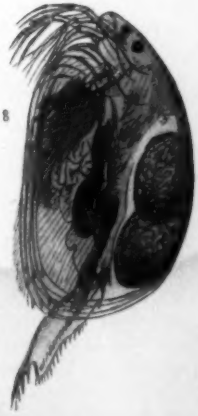
HAVING, during several short rambles amongst the mountains of Cumberland and Westmoreland, paid considerable attention to the microscopic Crustacea which inhabit the numerous lakes and tarns of that district, I propose, in the following pages, to offer a few remarks relative chiefly to the distribution and habitat of the various species, and also to describe briefly two or three new or little-known forms. And though I take the group known as *the* English lakes, *par excellence*, for the groundwork of my remarks, I shall also include therein to some extent the lakes of Northumberland, Dumfriesshire, Selkirkshire, and Kirkcudbrightshire, amongst which I have spent many pleasant days with net and collecting bottles. The lakes included in this programme may indeed be looked upon as forming in themselves a pretty well-defined group intermediate between those of the Scottish Highlands on the one hand, and of the Southern English Lowlands on the other. Whether the Crustacea of the more northern Scottish waters differ materially from those of the south cannot now be stated, as they have yet received scarcely any attention; but from all that we know of the lacustrine Crustacea of the English Lowlands, it may confidently be asserted that the difference is here very great indeed.

And it may be interesting to tourists with a love for natural history that now begin to find the geology, botany, and entomology of our favourite resorts pretty well worked out, so far as the discovery of new things is concerned, to know that the microscopic Crustacea of our ponds and lakes, and especially of *mountain* lakes, are sure to afford novelties to the diligent observer for many a year to come. Not that the discovery of new species ought to be the chief ambition of the naturalist, nor that even this may not yet be done by the hard-working botanist or geologist; but there is, nevertheless, a legitimate pleasure in discovering and describing forms of life which have been hitherto unknown; and in no branch of investigation are we, perhaps, more likely to find it, than in that of which we are here treating.

The higher groups of Crustacea (Amphipoda and Isopoda), which are abundantly represented in lowland ponds and streams by such creatures as *Gammarus pulex* and *Asellus aquaticus*—animals of the sandhopper and woodlouse type—are scarcely to be found in mountain lakes, though we occasionally meet with them in very small bog-pools on the hill-





British Lacustrine Entomostraca.

sides, where there is a rank vegetation of Sphagnum and water-grasses. Very probably, however, in the more sheltered and weedy portions of the larger lakes they would be found; but be this as it may, the microscopist will be disposed to think that their "room is better than their company," as they have neither rarity nor beauty to recommend them. G. O. Sars and other naturalists have, in some of the large lakes of Sweden, obtained some curious *marine* Amphipoda by dredging, thus affording an interesting confirmation of the fact, that the Scandinavian peninsula is slowly rising from the sea; and though similar discoveries might not reward the naturalist in our English lakes, it would still be worth while to try the fortune of the dredge in some of them.

The Crustacean inhabitants of our lakes belong, then, almost exclusively, to the order Entomostraca; and of the three divisions of that order which constitute the great bulk of the British fresh-water species (Cladocera, Ostracoda, and Copepoda) the Ostracoda are, on the whole, very poorly represented. One very common species, *Cypris ovum* (Jurine), exists in almost every collection of water, from the lowest to the most elevated; and in company with it, very often, a closely allied species, *C. lævis*, Müller. *Cypris compressa*, Baird, is of rather rarer occurrence; while in Loughrigg Tarn, and some of the small lakes of south Northumberland, I have found a very fine species (*C. obliqua*, Brady), which is closely related to, if not identical with, *C. elliptica*, Baird. *Notodromas monachus* (Müller) occurs abundantly in many of the lochs of Selkirkshire and Dumfriesshire, as also a little member of the family Cytheridæ, *Limnocythere inopinata*, Baird, which is probably much more common than it appears to be, but may very readily be overlooked, owing to its minuteness, and to its living almost entirely amongst mud.

The group Copepoda includes several lacustrine genera—Diaptomus, Cyclops, and Canthocamptus—but the various species have not as yet been adequately investigated.

The third great division, Cladocera, is much more numerously represented, and, so far as mountain districts are concerned, forms much the most interesting section. It is not needful or desirable to occupy the pages of this magazine with technical descriptions of these species, especially as a monograph of the more important families, comprising descriptions of all the species, has recently been published, and is easily accessible to all who are interested in the subject.* My

* "A Monograph of the British Entomostraca, belonging to the families Bosminidæ, Macrothricidæ, and Lyncеidæ." By the Rev. A. M. Norman, M.A., and George S. Brady, M.R.C.S., C.M.Z.S. With six plates. London: Williams and Norgate. 1867.

purpose here extends only to the description of certain forms found since the publication of the monograph referred to, and to the presentation of a few observations relative chiefly to distribution. And before proceeding to notice the various species seriatim, a few general remarks will not be out of place.

In considering the question of altitudinal distribution, it is quite possible that we might arrive at erroneous conclusions, owing to the mixing up of other accidental circumstances not connected solely with elevation. We find that Entomostraca are usually most abundant where there is a profusion of vegetation; in little sheltered bays, margined with sedge and rushes, and bearing luxuriant beds of Myriophyllum, Potamogeton, or other water-plants—lovely little inlets, which we may find plentifully on the shores of Windermere and Derwentwater. And when we notice that in elevated tarns the number, both of species and individuals, is comparatively small, it is well to remember that this may partly depend upon the fact that these sheets of water are mostly, owing to their exposure and want of shelter, almost entirely destitute of vegetation, except of a very stunted kind; so that the poverty of the fauna is doubtless dependent partly on these causes, and only indirectly through them on elevation and temperature. For it is not unusual to find in pools close to the margin of some lake a Crustacean fauna totally different from that inhabiting the lake itself. Thus, in some pools on the shores of Ennerdale Water, which had formed, apparently, in the hollows left by turf-cutters, and were filled with Myriophyllum, Utricularieæ, and Potamogetons, I took an astonishing number of various Daphniæ, Lyncei, etc.—seventeen species in all; while along the whole length of Ennerdale Lake itself I could not succeed in capturing a single specimen of any kind. But the margins of this lake are excessively barren and stony; so much so, that in walking along its northern shore I could not detect a single patch of weed, and the net, when put into the clear water, collected nothing but little masses of spawn—of what animal I do not know. Still, I have no doubt that a prolonged search might have revealed spots more favourable to microscopic life, and that, even where no vegetation existed, Entomostraca might perhaps have been found—if not then, under other conditions of water or atmosphere. For vegetation does not appear to be absolutely essential to the lower forms of animal life. I have taken various Entomostraca in water where no vegetation, at any rate, higher than Diatoms or Desmids, existed; but in such situations they are always scanty, if existent at all, and the number of species capable of living under such conditions seems to be very limited.

In Ennerdale Water, however, this paucity of animal life would appear to be distinctly the result of lack of vegetation: it cannot be dependent on elevation, for the level of the lake is only 369 feet above the sea, and, as has been noticed, the pools close to it swarmed with life. It may be noted also that the members of the family Daphniadæ scarcely ever occur, except where there is abundance of vegetation, while the Lynceidæ seem to thrive well on a stunted cover of *Lobelia Dortmanna* or *Isoetes lacustris*.

It may be interesting here to place side by side (as types of the very wide difference existing between the Crustacean faunas of weedy pools of low elevation, and exposed mountain tarns of great elevation) lists of the Entomostraca obtained in two such localities.

Pools in Ennerdale: height above the sea, 370 feet.—*Daphnia reticulata, D. pulex, D. mucronata, Acantholeberis curvirostris, Ilyocryptus sordidus, Sida crystallina, Bosmina longispina, Lynceus harpæ, L. quadrangularis, L. elongatus, L. truncatus, L. globosus, L. barbatus, Eurycercus lamellatus, Diaptomus castor, Cypris lævis, C. ovum.*

Angle Tarn, under Bowfell: height, 1553 feet.—*Bosmina longispina, Lynceus elongatus, L. guttatus, L. exiguus, L. testudinarius, L. sphæricus.*

Daphnia Jardinii, Baird (Figs. 9, 10).—This curious species has, I believe, not been previously figured; and, indeed, I am not aware that it has been noticed by any observer, except Dr. Baird (Edinburgh, New Philosophical Journal, vol. vi., 1857, p. 24). I took three or four specimens in Rydal Water in 1864, and from one of these the drawing given in the accompanying plate was made. Its claim to specific rank may, however, be reasonably doubted. The produced vertex, by which it is chiefly distinguished from *Daphnia pulex*, is known in the case of *D. mucronata* to be a variable character, and the form known as *D. cornuta* is acknowledged to be merely a variety of the latter species. *D. Jardinii* is indeed smaller and more slenderly formed than is usually the case with *D. pulex*, but I am not able to discover from my specimens any specific character more valid than that already referred to, nor does Dr. Baird's description indicate any such. On the other hand, it should be stated that the three specimens preserved in my collection all have the cephalic cornua, though of variable size and shape, and I do not remember that any specimens of the normal *D. pulex* occurred in company with them. The length of my largest specimen is one-sixteenth of an inch, exclusive of the posterior spine.

Daphnia pulex (Lin.) and *D. vetula* (Müll.) occur commonly in lowland pools; and in the peaty hollows in Ennerdale,

already referred to, I found also *D. mucronata* and *D. reticulata*, the latter in very great abundance. But in pools of this kind occurring at a greater elevation, the Daphniæ seem to give place to another member of the same family—*Acantholeberis curvirostris*—which will presently be noticed.

Sida crystallina (Müll.) occurs plentifully amongst reeds and rushes round the margin of lakes, but does not, apparently, reach any great elevation.

Acantholeberis curvirostris (Müll.).—This species is not uncommon throughout the British islands in pools of peaty water, ranging from near the sea-level to considerable elevations. It does not so often occur in clear lakes and tarns. Sprinkling Tarn, and Crag Lake, Northumberland, are the only such localities in which I have any record of its occurrence.

Ilyocryptus sordidus (Liévin).—A rare and curious species, of which I found two specimens in my gathering from the peaty pools in Ennerdale. It had previously been found, though very sparingly, in two situations in Northumberland and Durham.

Drepanothrix hamata, G. O. Sars, is of not unfrequent occurrence in the upland districts of the north of England and south of Scotland, frequenting lakes and clear water. In the Lake district, I have found it in Rydal Water, Blea Tarn (Langdale), Little Langdale Tarn, and Easdale Tarn.

Polyphemus pediculus, Müll., though common in the moorland lochs of Northumberland and southern Scotland, is not so in the Cumberland district, the only lake in which I have found it being Derwentwater.

Bosmina longirostris (Müll.) and B. longispina, Leydig, occur, one or both of them, in almost all pieces of water in the Lake district. The males of these animals differ remarkably from the females in having the anterior antennæ connected with the body by a sort of ball-and-socket joint, and in the tapered form of the abdomen. This sex is, however, rarely met with; the only place in which I have found it being a small rushy tarn on some hills, called the Humbles, on the north-western border of Northumberland. This pool contained abundance of the Bosmina, but scarcely any other species; and I found this to be the case also in a somewhat similar situation on the northern slope of Mickle Fell, in Yorkshire; but in this latter case my gathering contained no males.

Lynceus harpæ (Baird), a very common species in almost all clear pieces of water throughout the kingdom, and on the continent of Europe, seems little affected by elevation, being met with in almost all the pools, lakes, and tarns of the Lake district.

Lynceus macrourus, Müll., is much rarer than the preceding species, to which it bears a striking general resemblance. Buttermere, Derwentwater, and Blea Tarn (Langdale) are the only localities in the Lake district where I have met with it. It seems to be a lowland rather than an alpine species.

Lynceus quadrangularis, Müll., is still more decidedly of lowland proclivities, being quite one of the rarer species in mountainous districts, but almost the commonest of British Lyncei in the plains. I have taken it, however, sparingly in Grasmere, Easdale Tarn, Derwentwater, Blea Tarn (Langdale), and in pools in Ennerdale. Its place in the waters of the lowlands seems in mountain regions to be usurped by the following species:—

Lynceus elongatus (G. O. Sars)—Fig. 8—which may be looked upon as the form most characteristic of mountain lakes, its strongholds being bleak, elevated sheets of water, such as Stickle, Angle, and Sprinkling Tarns, while at low elevations, and especially in small pools, it is much scarcer. In the lowland and southern districts of England it is not at all met with. When living in high, bleak tarns, it is often of a very deep, opaque brown colour, verging on blackness, and sometimes appears to be almost the only animal inhabitant of the water; but in lower and more sheltered situations it to a great extent loses its deep colouring. A very remarkable peculiarity of *L. elongatus* is that the carapace, though normally consisting of two valves, like all the rest of the genus, is very often found to be made up of two or three pairs of valves superimposed one on another. This condition is seen in the specimen represented at Fig. 8 of our plate, the six layers of carapace being plainly indicated by the minute tooth at the lower posterior angle of each. In this condition the edges of the several valves occupy very various positions. Sometimes all three (and I have never seen *more* than three) are pretty close together, as in the figure; at other times the edge of the uppermost comes nearly in the middle of the animal. It is remarkable, too, that the several coats do not separate in the process of exuviation, for the sloughs, which are often taken in great numbers along with the living animals, constantly show the several valves in union just as when alive. I cannot yet say whether the young are born in the multivalvular state, or whether it is a result of growth, but in every copious gathering of *L. elongatus* many specimens in this condition are sure to occur, and in some they form almost the greater part of the whole. This is the more interesting when considered in relation to a very curious species of the same family, *Monospilus tenuirostris*, one striking character of which consists in a somewhat similar but much more pronounced multi-

plication of valves; and the question suggests itself—do we, in the case of *L. elongatus*, see a species which is undergoing a gradual transformation in the same direction?

L. elongatus occurs in all the gatherings which I have made in the Lake district, and is frequent also in similar situations throughout the north of England and Scotland.

Lynceus costatus (G. O. Sars), seems to be a tolerably common inhabitant of lakes and clear water in moderate altitudes, but is seldom found in more elevated and exposed situations. Buttermere and Derwentwater are the only two localities in our Lake district where I have met with it.

Lynceus guttatus (G. O. Sars).—Well marked forms of this species are undoubtedly very distinct from the foregoing, but I am disposed to doubt whether the differences ought not to be regarded as varietal rather than specific. It is not uncommon in similar situations, ascending, however, to greater altitudes, and ranging from the sea-level to a height of 1553 feet (Angle Tarn). The following are the lakes in which I have met with it: Buttermere, Thirlmere, Easdale, Langdale, Angle and Sty Head Tarns.

Lynceus testudinarius, Fischer, is a widely distributed and very well marked species, and appears to haunt indifferently water of all degrees of exposure and elevation. It occurs in my gatherings from Buttermere, Langdale, Angle and Sty Head Tarns, and from pools on Eskhause, at an elevation of about 2000 feet.

Lynceus exiguus (Lilljeborg).—A very small, but well marked species, occurring in almost all the waters of the lake districts, but more commonly in those of considerable altitude. I find it in Buttermere, Thirlmere, Derwentwater, Easdale, Langdale, Sprinkling, Sty Head, Stickle, Angle and Floutern Tarns, and in the river Brathay, below Skelwith Bridge.

Lynceus truncatus, Müller, is a common species in the low country, and at moderate degrees of elevation in the lake district, but is not so frequent in the higher mountain tarns, the greatest height at which I have found it being 915 feet (Easdale Tarn). It occurs also in Windermere, Grasmere, Rydalwater, Derwentwater, Langdale, and Blea Tarns; in pools in Ennerdale, and in the River Brathay.

Lynceus uncinatus (Baird).—This species is at once known by the upturned extremity of the rostrum and strongly toothed infero-posteal angle. Buttermere is the only one of the lakes in which I have found it.

Lynceus nanus (Baird), the smallest of the British Lyncei, occurs at all altitudes. I have noticed it in Buttermere, in Floutern, Blea, Sprinkling, and Sty Head Tarns, and in pools on Eskhause and Honister Pass.

Lynceus globosus (Baird). (Fig 7.)—One of the finest, and by no means one of the commonest of the British species, living always in clear water, where there is abundance of vegetation, and mostly in situations of no great altitude. In the lake district it inhabits Windermere, Grasmere, and pools in Ennerdale. From a specimen taken in the latter place our figure has been drawn. The shell, when closely examined, after the internal parts of the animal have been removed, is seen to be regularly reticulated throughout, but on the ventral margin the reticulations partially coalesce, so as to form concentric furrows. In the living state these markings are a good deal obscured, and give rise to an appearance of dotting or scaliness which does not really exist.

Lynceus barbatus, nov. sp. (Figs. 1, 2).—Carapace subsemicircular; dorsal margin boldly arched from the postero-superior angle to the extremity of the rostrum, which is long, slender, and acutely pointed, and projects beyond the ventral margin; ventral margin gently convex, fringed with spiniform hairs which commence about the middle, and gradually increase in length to the posterior extremity, where they end abruptly; posterior margin slightly angular above, rounded off below; anterior antennæ slender, about half the length of the rostrum; abdomen broad and short, superior margin deeply excavated, superior posteal angle produced and obtusely rounded, armed with about nine long and nearly equal spines, terminal claws slender and bearing a single small spine at the base; eye-spot situated nearer to the eye than to the extremity of the rostrum, and about half its size; shell devoid of reticulation or striation, but slightly waved round the margin, especially on the dorsum. Length one fifty-fifth of an inch.

This is a very distinct, and apparently a rare species. I have seen only four specimens, three of which were taken in Buttermere, and one in a pool in Ennerdale.

Lynceus sphæricus, Müller—(Fig. 6)—is found everywhere, from the smallest road-side pool to the most elevated mountain tarns, but is most abundant in somewhat foul and stagnant water.

Var. favosa (Figs. 3—5).—Closely allied to the last, and almost exactly similar in shape, except that the rostrum is perhaps somewhat longer and more slender. The markings of the carapace are, however, entirely different, consisting of very deep and conspicuous irregularly angular excavations, which are restricted to the head and the inferior and posterior portions of the carapace. The margins of the valves are always entirely free from these markings, but their distribution over the other portions is somewhat variable, and the parts not thus marked are quite devoid of reticulation, or any perceptible

structure, as represented in Fig. 5. In the typical form of *L. sphæricus*, on the other hand, the surface is regularly, but faintly reticulated, as shown in Fig. 6. This is most plainly seen in young specimens, but in older examples is often visible on the margins only, while the margins of the valves in the variety *favosus* are always, as has been said, quite destitute of sculpture. Length one fifty-eighth of an inch.

This form occurred plentifully in some small peaty pools on Eskhause, at an elevation of about 2000 feet. The peculiarities of shell sculpture lead me to suspect that it may be a distinct species, though it must be confessed that in other respects there is little or nothing to distinguish it from *L. sphæricus*.

EURYCERCUS LAMELLATUS (Müller) is common in all the low-lying lakes, but does not apparently inhabit those of great altitude. The only tarns in which I have found it being Langdale (340 feet) and Easdale (915 feet).

EXPLANATION OF PLATE.

Fig. 1.—*Lynceus barbatus*, nov. sp., female, x 84.
Fig. 2.—Abdomen of the same, x 210.
Fig. 3.—*Lynceus sphæricus, var. favosa*, female, x 84.
Fig. 4.—Abdomen of the same, x 300.
Fig. 5.—Exuvium of left valve, showing sculpture, x 84.
Fig. 6.—Marginal reticulations of *Lynceus sphæricus*, x 210.
Fig. 7.—*Lynceus globosus*, female, x 50.
Fig. 8.—*Lynceus elongatus*, female, multivalvular form, x 50.
Fig. 9.—*Daphnia Jardinii*, female, x 25.
Fig. 10.—Abdomen of the same, x 40.

THE PHILOSOPHICAL INSTRUMENTS IN THE PARIS EXHIBITION.

BY C. R. WELD.

Amidst the vast gathering of products of human industry and invention, which attracted millions of visitors from all countries to the French metropolis this year, the objects classed under the head of Philosophical Instruments hold very high rank. For it is, to a great extent, by the agency of these instruments that the present generation enjoys comforts and luxuries wholly unknown to the early inhabitants of our globe.

While contemplating with feelings of wonder and awe the pyramids of Egypt, we cannot but remember that though they are stupendous monuments of the former rulers of that country, they are also monuments of slavery and drudgery, for by brute force were they heaped up, thousands of toilers and long years being required to do that which now, by the aid of machinery, could be effected in a few months. When the inhabitants of a country are condemned to unceasing labour, progress for the race is impossible. "How," remarks Solomon, thinking probably of the slavery of the nations around him, "shall he that toileth all day long have knowledge," and assuredly the more that we can make machinery perform offices of manual labour, the more will man be raised in the scale of civilization, provided always, that with the leisure thus afforded him, suitable education is provided. For, just in proportion as the exertions of those who toil are aided and systematized by the employment of force-evolving machines, will there result surplus wealth, more and more leisure for all, an educated class spreading wider and lower; in a word, all that is man's proper destiny—progression in happiness.

How greatly machinery is indebted for its perfection to philosophical instruments is well known. Mr. Fairbairn, the eminent engineer, says that when he first went to Manchester, the whole of the machinery required for the mills in Lancashire was made by hand. Now tools, which may be almost regarded as philosophical instruments, so exquisitely accurate and highly scientific is their construction, are employed for this work. The high character of modern British machinery is due to the great pains bestowed on the tools used for its fabrication, a large proportion of which are made by Mr. Whitworth. With the wonderful measuring machine invented by this gentleman, demonstrating the one-millionth of an inch,* and his true plane,

* Mr. Whitworth has presented one of these really marvellous machines, and three of his true planes to the South Kensington Museum.

he is enabled to produce tools of an accuracy hitherto unknown, while these in their turn create machinery which has contributed largely to make our country famous and wealthy.

But philosophical instruments embrace a wide range of utility. By their aid we are enabled to explore with safety deep mines pregnant with the fierce fire blast, the astronomer guages the heavens, and guides the mariner over the pathless ocean, and the wonderful phenomena of light, heat, and sound, are examined and made to minister to the wants and comforts of mankind.

The Official Catalogue of the Paris Exhibition enumerates 490 exhibitors of philosophical instruments. At the Exhibition of 1862, the number was 351. Looking at the countries of the former exhibitors, we cannot help being struck by the spread of philosophical science over the globe. For, while the exhibitors of scientific instruments at the International Exhibition of 1862 came, with few exceptions, from well-known countries, several at the Paris Exhibition represented nations which we have hitherto regarded as but semi-civilized.

As astronomical instruments show mechanical progress and invention in their most refined development, we shall commence with them. The instruments of this description by no means represented the high perfection to which their makers have attained. This, however, is not surprising. Astronomical instruments are, as a rule, far too valuable to be sent to an Exhibition. There were, nevertheless, some fine equatorials exhibited.

The largest of these instruments was constructed by Brunner, of Paris, for the Boulik Observatory in Egypt. The object-glass is 8·4 inches in diameter, and it is provided with a very perfect clock movement.

Mr. Dallmeyer also exhibited an excellent six foot equatorial with a 5 inch object-glass. A notable feature of this fine instrument is that the same clock sets two circles in motion, one of which shows sidereal time, while the other moves the telescope. M. Evrard, of Paris, exhibited a large astronomical telescope with a 9·2 inch object-glass, but the performance of this instrument was not equal to that of Mr. Dallmeyer, which on competitive trial was found to be the best refracting telescope in the Exhibition. The superiority of this, and other English astronomical instruments, is partly due to the excellence of the optical glass made by Messrs. Chance, of Birmingham. These gentlemen, and M. C. Feil, of Paris, manufacture the best optical glass.

Reflecting telescopes, which have been highly instrumental in enlarging our acquaintance with the heavenly bodies, and especially with the nebulæ, were very poorly represented. One,

however, exhibited by Secretan, of Paris, was in all respects a most excellent instrument. The chief interest consisted in the speculum, which was one of Foucault's.

Instruments made upon this principle by English artists are so well known to readers of THE INTELLECTUAL OBSERVER, that I need not dilate upon their merits, or explain their construction.

The display of mounted and hand telescopes for military, naval, and travelling purposes, was extremely large and excellent. The most important novelty in these instruments was to be seen in those exhibited by T. Ross and Dallmeyer. Their focal length is only from nine to ten times the diameter of the clear aperture; notwithstanding which, they combine excellent definition with great portability. Messrs. Beck exhibited new and very ingeniously constructed binocular telescopes with which some extremely interesting features connected with binocular vision can be examined. A vast variety of binocular opera-glasses were exhibited by various makers. The low prices of M. Bardou's small telescopes and opera-glasses considered in connection with their excellence, is astonishing. He manufactures enormous quantities of these instruments for England, where they obtain a ready sale.

France and Prussia made an extremely fine display of alt-azimuth, meridian circles, and transit instruments. Those exhibited by Brunner of Paris were highly remarkable for combining the great desiderata of lightness and rigidity, and for being applicable either to astronomical or geodisical purposes, both circles being read off by means of micrometer microscopes. The graduation of these instruments was excellent; instead of the figures being cut on brass or silver, they are white on a black ground, and can be read with very great ease.

To no new discovery are philosophical instrument makers more indebted than to aluminium. This light and beautiful metal is peculiarly suited for astronomical instruments. Besides its great lightness, it is extremely rigid, and but little liable to tarnish. Many instruments in the Exhibition were made of this metal, and particularly of bronze aluminium. This is composed of ten parts of ordinary aluminium, and five of copper, and it possesses a strength both vertical and transverse far exceeding that of wrought iron. This metal is especially valuable in the manufacture of sextants, which require to be held in the hand, and often for a long time. Bearing in mind how highly important a part the sextant plays in navigation, it is lamentable how worthless a large proportion of those instruments are. Happily, however, great pains have been lately taken by philosophical instrument makers to improve them, and with considerable success. The show of sextants at the late

Exhibition was excellent. The great desideratum of attaching an effective artificial horizon when the sea-line is obscured, may be said to have been attained. Eminent makers of optical instruments will always supply a good and reliable sextant; but we may observe that no English mariner need now go to sea in doubt respecting the performance of his sextant, as the British Association for the Advancement of Science have organized measures by means of which sextants can be efficiently tested at the Kew Observatory.

The surveying instruments exhibited were greatly superior to those at the Exhibition of 1862. With the theodolite, which is certainly the fittest instrument for measuring terrestrial angles with precision, and which has displaced the separating circle on the continent, very great pains have been taken to obtain precision with compactness. The theodolites exhibited by London, Paris, Berlin, and Vienna makers were admirable, as also were those shown by J. Kern of Aarau in Switzerland, who employs many hundred hands in making these and other instruments. The Industrial Institution of Lisbon also exhibited several well-made theodolites. A very ingenious stenographic and orthographic machine was exhibited by Cavaliere Rossi of Rome, with which he has made a very trustworthy survey of the catacombs under and around that city. A very good display of telemeters and planimeters was made by France and Prussia, both of which nations have used these instruments extensively in field operations during war.

A very large display by various countries was made of mathematical and drawing instruments. Those exhibited by Elliott Brothers, maintain in all respects the high character of their house. Excellent instruments of this description were also exhibited by Gravet-Tavernier of Paris, J. Kern of Aarau, and Haff of Munich. The extremely low price of the instruments by these makers, as compared with those made in England is very remarkable. The Swiss and Bavarian makers sell a magazine case of excellent instruments containing a beam compass, proportional compass, six pairs of ordinary compasses of various dimensions, several excellent drawing pens, graduated rulers, sectors and protractors, all in electrum metal, for £3 18*s*. The United States of America, which formerly imported nearly all their dividing-engines and mathematical instruments, now manufacture largely and well. The instruments exhibited by Darling, Browne, and Sharpe, of the above country, are admirable. The accuracy of their steel straight-edges is very great, and the divisions on all their scales, which are effected by machinery, are extremely clear and accurate. These articles are manufactured very largely for the engineering establishments of the United States, and also for the English market.

Several excellent cathetometers were exhibited. The most delicate were those made by Bauer, of St. Petersburg, under the direction of Professor Jacobi, and by Perreaux and Guillemot of Paris. These instruments show with great accuracy the distance between two points in a vertical line to the 0·0002 of an inch. A pantograph contrived by M. Gavard of Paris, who has long been engaged in perfecting this instrument, was highly deserving of notice for the new application that it involves. By its means duplicate figures can be engraved on several copper cylinders, and impressions taken from them. The invention is likely to be introduced in the calico printing trade.

The great attention devoted during recent years to meteorology has led to considerable improvements in instruments for registering meteorological phenomena. The exhibition of these in Paris was very complete, comprising a great variety of barometers, thermometers, anemometers, rain-gauges, etc. By far the most important exhibition in this department was that by Padre Secchi, Director of the Observatory in the Collegio Romano, who showed his automatic meteorological apparatus, invented, and almost entirely constructed, by himself. This, which is by far the best apparatus of the kind in existence, registers, by means of curves traced on paper, the temperature, pressure of the atmosphere, direction and force of the wind, amount of rain, and humidity. The apparatus, which is acted on by clockwork and voltaic currents, performs admirably, and its registrations are worthy of the greatest confidence. The construction of this elaborate and highly ingenious apparatus is most creditable to Padre Secchi; and the more so, as he derives very little assistance from Government funds. A new barometer was exhibited by the inventor, Mr. Clum, of the United States. He has called it the Aëlloscope Barometer, from *ἀέλλα*, storm, and *σκοπε*, to view; its object being to indicate the powerful atmospheric vibrations which precede storms. It is certainly extremely sensitive, but so complicated and costly, that it is not at all likely to come into general use. The lowest price of this instrument is 1000 dollars. A new mercurial barometer, of a very sensitive nature, and extremely portable, was exhibited by Messrs. Beck. It has been tested to a height of 14,000 feet, and found to be extremely accurate.

The Aneroid Barometer,* which has become a very trust-

* This instrument was invented by Conté (known for the drawing-chalks which bear his name), when he was director of the Aerostatic Establishment at Meudon, founded by the first Napoleon for campaigning purposes. Conté was desirous to make a barometer that should be smaller and less liable to injury, than the usual mercurial instrument; but though he constructed that now known as the Aneroid, he was not able to make it sufficiently precise to be depended upon, and thus left it for Vidi and others to perfect it.

worthy instrument, has, in the hands principally of Naudet, of Paris, been still further improved, and especially those intended for pocket use. Bourdon's metallic barometers, composed of coiled tubes exhausted of air, and hermetically sealed, have also been considerably improved, principally by Richard, of Paris, who states that they now require no correction.

A great variety of excellent thermometers were exhibited, principally by foreign makers. No important improvement was, however, apparent. Those made by Reverend, of Paris, are remarkable for their clear and well-cut graduations. Mr. Bache, of the United States, exhibited a deep-sea thermometer of novel construction, for registering the temperature by the action of metal bars. M. Bréguet's metallic thermometer has been further improved, so as to render it more sensitive. This instrument has been lately used by Mr. Wheatstone, in connection with his invention for ascertaining the temperature at distant places by telegraphy. By means of magnets and connecting wires, a Bréguet thermometer, placed on the summit of Mont Blanc, can be read off at Chamouni, or the temperature at great depths in the earth or ocean ascertained in the same manner at any moment.

Electricity, and especially electro-magnetism, was largely illustrated. The apparently inexhaustible applications of this mysterious force are continually taxing the inventive power of man. The grand desideratum, however, of obtaining a motive force which shall supersede that of steam has not yet been discovered, the few machines of this nature in the Exhibition being at once weak and costly. The great mechanical difficulty which prevents the application of electro-magnetism as motive power in prime movers is the short distance through which the action of magnetism extends. This has been sought to be overcome by calling into action, *seriatim*, a number of electro-magnets. It is possible by this means to work a crank of one or two inches in length with sufficient power to turn a small lathe; but it admits of easy demonstration that an electrical machine, with zinc for its fuel and acid to burn it, cannot be made to rival steam-engines.

Mr. W. Ladd exhibited a very ingenious and energetic electro-magnetic machine, embracing the new principle of augmenting indefinitely the power of an electro-magnet by currents produced by itself. The apparatus can be employed for lighthouses, or other purposes. It is driven by a one-horse power steam-engine, by which force effects are produced quite equal to a fifty Grove's battery.*

Very beautiful illustrations were exhibited of the application

* Mr. Saxby has lately discovered that by passing electro-magnetic currents through masses of iron, internal flaws in the iron can be unfailingly detected.

of the laws of electro-magnetism to astronomical purposes. The Americans were among the first to apply them to determine the difference of longitude at various places. The most interesting object in this department of electricity was Professor Bond's astronomical clock and chronograph, which were used for ascertaining, in connection with the Atlantic Telegraph Cable, the difference of longitude between Newfoundland and Valentia. The apparatus of this clock and chronograph are so contrived, that the precise epoch of an observation can be registered to the one-fiftieth part of a second. Such is the wonderful accuracy of observation to which modern science has attained. As appertaining to this apparatus, Sir W. Thomson's ingenious electro-dynamometer may be noticed, which was exhibited by Messrs. Elliott. Sir W. Thomson has been long engaged in perfecting this instrument, which was of signal use in laying the Atlantic Telegraph Cable; and he has lately constructed one of such delicacy, as to be capable of measuring differences of *potential*, ranging from one-four-hundredth of a Daniell's cell up to 100,000 cells.

The best chronoscopes and chronographs were exhibited by France. The principal use of these instruments is to determine the velocity of projectiles by electricity, and to register the precise time at which an astronomical observation is made. Those constructed by E. Hardy for the French Government are admirable specimens of mechanical ingenuity.

A very clever contrivance for engraving by electricity was exhibited in the machinery department. A metal plate, having the design which is to be engraved drawn on it with a particular kind of ink, is slowly rotated, while several other plates, on which the design is to be engraved, are also slowly rotated. The engraving is then effected by applying a diamond cutting-point to the face of each plate, which is pressed against it, through the agency of an electrical current, whenever a blunt point presented to the first plate encounters the ink, but is withdrawn at other times. The point presented to the first plate is a feeler which determines by electrical agency whether there is ink beneath it or not. If there is, the diamond points opposite to all the other plates are pressed in; if there is not, they are withdrawn, and do not act.

A new and powerful electrical machine was exhibited by P. Töpler, of Riga. It acts on the principle of multiplying induction resulting from a series of glass parallel discs rotating rapidly. The sparks produced by this machine are very numerous and powerful. France exhibited a great variety of magnificent magneto-electric apparatus, constructed for the Ecole Polytechnique by Nollett and Ruhmkorff. The best application of electricity for the production of electric light

was exhibited by M. Serrin, whose electric lamps for light-houses are now in general use in France. This light is so intense, that it has been used with great success to obtain photographs of the catacombs under Paris. The applications of electricity to telegraphy and horology were well represented, but they were not included in the department of philosophical instruments. A whimsical application of magneto-electricity was exhibited by Trouvé, of Paris, in the form of various quaint figures, mounted as pins, etc., which are set in motion by miniature electro-magnetic apparatus.

The beautiful and interesting phenomena of diffraction and polarization have caused many ingenious contrivances to be invented for their display and examination. By far the best and most complete polarising apparatus was that exhibited by Duboscq and Bertaud, of Paris.

One of the most interesting novelties in philosophical instruments is the spectroscope, which has made us acquainted with several new metals, and to a great extent with the solar photosphere. The startling success that has attended these philosophical investigations has led to the spectroscope being greatly improved. Extremely fine instruments of this description were exhibited by France. The most remarkable in all respects was that shown by Duboscq. The beam in this instrument is successively transmitted through six prisms of sixty degrees, by which means the separation of the bands of the spectrum is greatly increased. By an ingenious contrivance these prisms can be easily moved in combination.

The recent exhibition, like that of 1862, has been very complete in its display of microscopes, accessory apparatus, and objects. It is gratifying to be able to record that our country maintained its pre-eminence in these valuable instruments. The microscopes of Messrs. Beck, T. Ross, and Dallmeyer were found, on trial, to be the best exhibited. As was to be expected, the binocular microscope is gaining rapidly in estimation. The principle generally adopted is that of Mr. Wenham's, admirable specimens of which were exhibited by several makers. While willingly testifying to the great excellence of our English microscopes, it is very satisfactory to be able to add that the microscopes exhibited by continental makers were in all respects superior to those exhibited by the same makers in 1862. The microscopes of M. Hartnack, of Paris, were especially good.

It is remarkable that the continent, and especially France, should not have shone in the late Exhibition in calculating machines. Pascal, with whose name unwarrantable use has lately been made with respect to the forged letters attributed to him, invented an arithmetical machine; and Leibnitz in-

vented another, of a more complicated kind. But although several extremely ingenious calculating machines have been constructed since that period, the only machine of the kind in Paris was that exhibited by C. Thomas, of Colmar, which multiplies 8 figures by 8 in eighteen seconds; divides 16 figures by 8 in twenty-four seconds; and extracts the square root of 16 figures in ninety seconds. The price of this machine was £20. It is to be regretted that a specimen of the extremely beautiful calculating machine invented by the Messrs. Scheutz, of Stockholm, was not exhibited. One of these machines is employed in calculating a new life table in the Registrar General's office in London, and simultaneously prints the results.

It would greatly exceed our limits to even briefly notice the numerous objects falling under the head of miscellaneous philosophical instruments. A few, however, are too important to be omitted. Among them may be classed Lissajous' and Desain's apparatus for representing acoustic vibrations optically and graphically, exhibited by the maker, M. Kœnig. This apparatus is the most perfect that has been devised for demonstrating the various combinations of rapid vibratory movements. Many other beautiful and novel acoustical instruments were exhibited by M. Kœnig, who has been for many years engaged with great success in investigating the laws of sound.

The collection of spectacles by continental makers was extremely large; but as the eminent British makers of these useful articles did not exhibit, no comparison can be instituted between them and the former. How much machinery has done to reduce the price of spectacles is apparent by the fact that the house of Morey, Baillet, and Co. manufacture excellent spectacles, in good steel frames, which are sold at 2*s.* 6*d.* the dozen pair. In nearly all the spectacles exhibited provision has been made to enable the axis of each eye to coincide with the central spot of the lens, without which arrangement spectacles must be always defective.

In the department of philosophical instruments, the Paris Exhibition contained a great variety of models of machines, drawings for teaching the physical, natural, and musical sciences, anatomical preparations, etc. With scarcely an exception, all these were contributed by continental countries, the governments of which are far more disposed to afford facilities for technological instruction than that of our own. The objects of this nature exhibited by France, Belgium, Prussia, Italy, and Russia, were admirably adapted for the above purpose. There was a very interesting exhibition in the department of anatomy, by Dr. Brunetti, of Padua, who has discovered a process by which, in thirty hours, he can

preserve the human and other bodies. The preparations are life-size, and so little changed by the process, that they can be used for anatomical purposes, nor are they affected by time or insects. A committee of the Paris Academy of Sciences has been appointed to examine and report on Dr. Brunetti's invention, with the view of purchasing the secret of his process, should it be found to be valuable.

In conclusion, we may remark, that although no just comparison can be made between the merits of foreign philosophical instrument makers and those of our own country, in consequence of the absence from the Exhibition of many of our most eminent makers, there is no doubt that in this department, as well as in many others, continental nations show great progress. We have, indeed, only to examine the foreign mechanical products to be made aware that the excellent and comprehensive practical education afforded throughout the greater part of the continent, and especially in Prussia, has already borne valuable fruit; and if we desire to keep up in the race of progress, we must be at more pains to disseminate technological education among skilled artisans.

The philosophical instruments lately exhibited in Paris were not, it is true, remarkable for any great novelty, but they were highly remarkable for their general excellence; and this was often to be found in instruments made in countries which a few years ago did not produce an ordinary barometer. It was also a very noticeable feature that the foreign instruments are much more moderate in price than the English, which is principally due to the lower rate of wages paid to continental workmen.

To the philanthropist who desires to see the advance of mankind, this progress is extremely gratifying. "The introduction of noble inventions," says Lord Bacon, "seems to hold by far the most exalted place among all human actions. This," he adds, "was the judgment of the ancients, who accorded divine honours to inventors." And by the improvement of existing, and construction of new philosophical instruments, we have every reason to believe that the prosperity and happiness of the great family of mankind is largely advanced.

LUNAR SKETCHES.—TRANSITS OF JUPITER'S SATELLITES.—OCCULTATIONS.

BY THE REV. T. W. WEBB, A.M., F.R.A.S.

In our last number we gave the commencement of a few original rough sketches of the lunar surface in the neighbourhood of *Eratosthenes* and *Copernicus*, as a small contribution to the materials which in great measure yet remain to be collected for future comparison and study. We now propose to continue our remarks upon the same interesting region.

Eratosthenes.—The following notices may be referred to, concerning this crater.

1856. Jan. 15. $3\frac{7}{10}$-inch achrom. "One-third of ring faintly enlightened beyond terminator, and just connected with it by a dimly lighted ascent," showing that the ground in the neighbourhood of this great eruption had been upheaved like that round *Copernicus*, though in a much less conspicuous degree.—1861. April 18. 5½-in. achrom. Terminator through *Tycho* (48) and *Fontenelle* (N. of *Plato*, 38). "The wall a grand sight in itself. Its N.W., W., and S. slopes to a considerable distance are most curiously roughened with small hillocks and ridges, whose general direction is concentric with the wall, and whose appearance bespeaks a former semi-fluid condition," as, perhaps it might have been added, their arrangement would rather suggest the ejection of blocks than the flow of lava. Such ideas, however, can only acquire weight from extended observation.—That the surface hues in and around it are of a decided character appears from the following notices. 1864. Aug. 13. 5½-in. achr. "The wall still casts a penumbra on each side, yet the interior begins to show local colour." Aug. 15. (1d. 16h. before Full.) "Penumbra gone; a strange mixture of light and duskiness on its site." How these shadowings are arranged will appear, to some slight degree, from the two following entries, which I quote just as they stand, having given no further attention to the region, and being at present unable to examine how far they admit of being reconciled. 1864. July 22. (3d. 17h. *after* Full.) 5½-in. achr. "*Eratosthenes* has its E. side filled with a dark lake, or rather, two such spots joined by a narrower neck: a small dusky spot lies also at the W. foot of the central hill." 1867. Nov. 8. (3d. *before* Full.) 9½-in. silvered "With" mirror. "*Eratosthenes* now all in local colour; from point of junction of *Apennines* round the E. semicircle, the outside glacis of wall shows a curious dark grey border. This is penetrated in two places by the streaks of *Copernicus*, which extend perhaps (but qu?) across *Eratosthenes*

itself. Curious as to chronological sequence." It is just possible, however, that some process affecting the reflective power of the surface may at this time be working here; for B. and M. say that this crater is "in Full Moon not very distinct: we only see a very undefined faint light spot in a vicinity almost equally luminous." No mention is made of any darker portions, or of their being so situated as to indicate the position of the ring, and the description certainly does not tally well with present appearances. This is a peculiarly suitable spot for examining the question whether the Full Moon markings are unchangeable. Fixity, of course, if established by a long course of observation here, or anywhere else, would be no argument for its universal prevalence, since a state of quiescence in this respect might be attained at very different epochs in different regions; but should the reverse be clearly ascertained in a single well-marked, even though minute, case, it need not be mentioned that one distinct, incontrovertible affirmative weighs down any number of negative instances, and merely throws back the date of their changes to a pre-historic period. Sketches at the telescope, in lamp-black, Indian ink, or sepia, if really careful and trustworthy, would be very valuable, and in some hands made with much facility. There is this great convenience attending them—that the ground-markings they represent are much less fugitive than the actual shadows indicating the relief of the surface, and that many more opportunities are afforded in each succeeding lunation for the production of such designs, than of delineations containing ordinary effects of light and shade. And hence, by the way, as regards that great desideratum, a good map of the Full Moon, much more might be effected in a corresponding time than in the case of the details of actual relief. Even a single observer, possessed at once of accuracy of eye and artistic training of hand, might make a great advance in the right direction. To such an one (but more than one, we trust, may be found) the experience of the Astronomer Royal for Scotland (Piazzi Smyth), himself eminent alike as astronomer and artist, may be acceptable. In sketching the *Mare Crisium*, at the request of the former Lunar Committee of the British Association, he found oil colours much preferable to water for producing a likeness under the required conditions. It need scarcely be added that a large scale would be required to follow his example with success. But to return to our immediate subject:

Sinus Æstuum.—1864. Dec. 6. 5½-in. achr. "The entrance of this dark plain is magnificent, and the curved banks lying obliquely over one another, but with a general parallelism to the mountain boundary, look like the rolling waves of some

viscous material, agitated just before consolidation." The remarkable appearance here referred to is not confined to this region. I have traced it in others of the so-called lunar seas: in the *M. Nubium* (M), the *M. Humorum* (N), the *M. Nectaris* (O), and near the E. shores of the *M. Serenitatis* (E); further search will probably detect it in other situations; and it is probably one of those significant features which deserve peculiar attention in any speculation as to the probable origin of existing configurations. Very imperfect at present such speculations must necessarily be; and whether they may ever assume the proportion of a consistent theory will depend first on diligence of examination, and next on the care and impartiality exercised in dealing with the materials of thought. At present they are but guesses and inquiries, worthy of being recorded only so long as they make no further pretension.

Stadius.—The curious discovery of a number of minute craters within this slight enclosure was made by Dr. Dobie, of Chester, with a 5½-in. object-glass in the summer of 1863. His obliging communication of it to myself led me to wish for an examination of the region, which I was unable to accomplish for a considerable time; the illumination suitable for such minutiæ being always transient, and the air not frequently sufficiently steady. However, 1865, Jan. 6, when the terminator was passing through the E. side of *Reinhold* (31) and *Bullialdus* (60), and definition, with haze and a cold N.W. breeze, was fine, but rippled over, and very unsteady, my 5½-in. achr. enabled me to make out 10 or 12 minute pits, similar to those in the crater-chains of *Copernicus*, but smaller, and without distinct rings; they were chiefly in S. and W., and none, I thought, in the centre. I detected them again 1866, Feb. 23, the terminator having passed beyond *Plato* (38) and *Tycho* (48) by the amount of their own diameters; and I have since seen them with my beautifully defining 9⅓-in. silvered mirror, but not under the favourable circumstances which they require. May we imagine that these are of modern date? The large maps of B. and M. and Lohrmann contain only one small crater in the S.W. part of the floor of *Stadius*, a crater which I think I have seen pre-eminent among the rest; but the others might easily have escaped the small aperture of B. and M., and Lohrmann's Sections and letterpress unfortunately do not extend so far: we must, therefore, suspend our opinion, and allow the probability to be decided by less ambiguous evidence elsewhere. In one respect this region is worthy of attention on the part of those who have a clear optical command of it: its circumscribed nature enables the little included cones to be counted and drawn with greater certainty than might be the case in a less definite area. We proceed now to the

Crater-chains of Copernicus.—To the details previously given, the following may be added.—1855, April 2. $3\frac{7}{10}$-inch achromatic; $\frac{1}{3}$ of ring of *Copernicus* enlightened. The row of craters casts a considerable external shadow (so 1866, April 23. $5\frac{1}{2}$-inch).—1861, April 18. $5\frac{1}{2}$-inch achromatic. "The W. portion which joins the ring of *Stadius* is on the terminator. It is evidently a low ridge, blown through in many places by a succession of little bowls, whose summits caught the sun in a wild, strange, confused manner, and exhibited two interrupted parallel lines of little, bright, irregularly-disposed specks."—1862, Feb. 8. $5\frac{1}{2}$-inch achromatic. *Copernicus* its own breadth within the terminator. The region "wonderfully seen, and in much fuller detail than in B. and M. I seem to see through and beyond all their work. The N. extremity of the crater-chain dies out in a faint narrow rill [cleft], otherwise than in B. and M. The S. and S.W. slope of *Copernicus* are thickly studded with very minute craters, omitted by them, but really forming an unbroken dotted continuation of the Crater-Region, as far as their *Copernicus* C [at the N.E. end of Riccioli's *Rhæticus*], and as far as (? if not beyond) their double crater *Copernicus* A, towards *Reinhold*. Thus it is evident to sense that the whole crater-region is posterior to *Copernicus*."—1862, April 8. $5\frac{1}{2}$-inch achromatic. *Copernicus* entered half its own breadth. "Very fine definition, tranquilly undulating, which would have defied photography, with cool but not severe N.E. gentle breeze—*Copernicus* a glorious sight; continuation of crater-chain most distinct all along S.W. slope."—1864, Dec. 8. $5\frac{1}{2}$-inch achromatic. Terminator through *Heraclides* (E. cape of *Sinus Iridum*, K). The row of minute craters ending with *Stadius* C (B. and M.) is confluent for a short distance, otherwise than they have figured it.—1865, Jan. 6 (see *Stadius*). The crater-chains "are very wonderful; they seem much more inosculating and rill-like than as given in B. and M., or than as I used to see them. Three or four craters N. of B. and M.'s C are evidently blown into one long trough."—1866, Feb. 23 (see *Stadius*). The crater-chain is "exceedingly rough and irregular, but casting some shadow; enough to show that the rings of the little pits are of a fair proportional elevation. It is much like a mole-run, with holes in it. It leads straight on to the E. side of *Stadius*." The simile here employed would be naturally suggested by a residence in the country, where such objects frequently meet the eye. In the course of the following autumn I came across a "run" of this nature in a meadow, fifty-four or fifty-five yards in length, ending by inclosing an oval space. Without including two small side branches, I counted upwards of ninety larger or smaller mole-hills on this ridge, nowhere more than two

yards, and often but a few inches, apart. To anyone familiar with lunar features, the resemblance in these cases is so striking, that it seems hardly possible at first to believe that it is a mere coincidence; but a little reflection will show that it can be nothing more. There can be no analogy between the operations of an intelligent and self-directing creature, burrowing intentionally just below the surface, and the mechanical working of a force which, obeying involuntarily the law of creation, is compelled of necessity to burst through and expend itself at once wherever the least resistance is offered. Schr., indeed, and B. and M. have spoken of the lateral working of elastic subterranean forces; but it is very difficult to conceive the *modus operandi*, especially in a case like the present, where the tunnelling is so superficial, and the vertical resistance can have been so slight; unfortunately, it seems equally difficult to suggest a less objectionable explanation. We are here, however, struck with at least one analogy, which is exemplified in innumerable situations and upon very varied scales in the Moon;—the great tendency pointed out by Sir C. Lyell in terrestrial volcanos "to shift their principal points of discharge."*—1866, April 25. 5½-inch achromatic. Terminator through E. wall of *Gassendi* (64). "Have not some of these pits become larger and deeper?"—an idea, however, which might arise from closer acquaintance. It pointed out a similar illusion in the case of double stars, which seem to widen as we are familiarized with them, and among such minute details every precaution must be taken against involuntary deception. —1867, Nov. 18. 9½-inch mirror. Terminator (in *wane*) close to *Linné*. "Crater-chains so evident at this distance from Terminator, that it is inconceivable how they should have been missed by Schr."

Copernicus.—Of this glorious object I have, of course, many notices.—1862, April 8. 5½-inch; *Copernicus* entered something more than half its breadth. "The outer E. slope of the ring showed a number of furrows radiating outwards, as though the interstices of lava-streams." These, as we have remarked on a former occasion, were discovered by Schr. (It may be added that, considering that these furrowings, of which he says he found scarcely any on the W. side, extend down to the immediate neighbourhood of the crater-chain; that the instrument employed was a powerful speculum of about 9 inches diameter; that the illumination must have been favourable; and that the observation bears every mark of care; it is very difficult to conceive how so curious an object could have escaped his earnest and careful gaze, had it been as fully developed, 1796, March 18, as it is now. A similar

* Memoir on Etna, "Philosophical Transactions," 1858.

remark applies to his observation of 1797, Feb. 6, when he discovered, with a power of 288, the cleft already described on the N.E. side of the glacis, and when he says the terraces of the ring were so sharply defined that he felt as though he could climb them. Contrast this with the fact that, without any previous knowledge of its existence, and without any special attention to its site, I detected this object, 1832, April 9, with an aperture of 3-inches of an ill-corrected fluid achromatic, bearing a power somewhere about 100.)—1864, March 17. 5½-inch; *Copernicus* entered more than its own breadth. "There are wonderful radiating streams, as of a continuous succession of blocks, or of lava cracked and roughened in cooling, extending to a long distance on every side. They are most visible in the present illumination through the E. semicircle—least distinct S.W. Through the W. semicircumference these streams seem to cover all the glacis even from the top of the wall; on the opposite shadowy side the terraces are so strongly marked that the radiations do not appear across them, though they cover the slope beneath. The S. half of the interior (or rather the S.E. quadrant, the S.W. being in shade) is all strewed with blocks—especially with 212 [a very keenly defining microscopic eye-piece]; the N. part is much smoother."—1864, March 18. 5½-inch. Terminator just beyond *Sin. Iridum*, and touching W. wall of *Gassendi*. "The interior terraces are shown by their shadow to have a convex outline, from the foot of the highest wall to the floor, indicating, perhaps, that in settling down the upper part was the most fluid."

1864, Dec. 8, 5½-in. Terminator through *Heraclides*. "A strange observation—definition marvellously sharp—I have very rarely seen it matched; but low clouds hanging around, and dissolving into rain so close over our heads, that when one of them was passing as a haze across the Moon, I found, by lengthening the focus, that a profusion of the minutest dark globules were streaming over the disc from the W. (somewhat like Messier's observation of the Sun), notwithstanding which the details, though pale from haze and a considerable amount of dew and rain on the object-glass, continued sharp, and the limb was fairly defined even when I tried a power (461 and Barlow lens reversed) which must have approached 700 or 800. *Copernicus* glorious, full of details, almost like Secchi [the engraving]. The S. half of the floor is very irregular; the unevennesses have more the aspect of streams flowing from the central cones than of single blocks. There is some, but a less degree of roughness in the N.W. quarter; I trace none in the N.E." [The particulars of this observation are given in full, as being instructive in

their own way. They show under what unexpected circumstances the greatest distinctness may be found; and that, therefore, no night should be condemned untried; and that it is extremely difficult for an inexperienced person to form, from a brief trial on celestial objects, an accurate opinion of the quality of any *large* instrument: *small* apertures are far less affected by atmospheric disturbance.]—1865, Mar. 6, 5½-in. Central hill beginning to appear. "*Copernicus* very magnificent, covered with hillocks and roughnesses, which, under the present illumination, so extend over the terraces of the ring that the summit of the latter does not appear as though it rose clear above the external lava-streams, but as though they had flowed over it."—1866, Feb. 23, 5½-in. "W. ring just beginning to come on terminator: marvellously rough glacis, but no distinct radiation.—1867, Dec. 5, 9½-in. mirror. "It is very interesting to mark the contrast between the bright white illumination of the interior of the wall and its terraces on the E. and the colossal heaps of grey scoriæ, which look as if they had been rolled over the summit of the ring on every side, and remained piled one above another even to its summit; it being quite evident in this illumination that the wall has nowhere a distinct existence above them. The radiations, which are very clear, do not begin till a long way below." 2h. later, when the ring was distant a diameter from term., it is noted that the E. side, "at some little distance from its summit, casts a black shadow for a considerable length, giving the mistaken impression of a perpendicular cliff, or even overhanging edge, so that there must be a sudden increase of declivity at this part; the radiations are all below, and the upper part of the ring looks exactly as though it had been rolled over the lip of the crater, or forced by pressure out of the interior, subsequent to the formation of the radiated surface; the lava-currents, if they are such, and not streams of blocks or scoriæ, must have been in a more fluid condition than the wall, both as extending further, and over a more gentle slope. The internal terraces look as though they had resulted from the slipping back into the interior of matter which had failed to be projected over the lip." 1¾h. afterwards, "the black shadow is passing off, and there is a distinct impression that the ring proper is convex on the outside in a vertical section," as the terraces, at least W., had been found to be in the interior. "Above this there is a low, narrow, irregularly bent central crest or lip, of considerable steepness, which seems to divide the ring proper—*i.e.*, the convex part without, and the terraces within, into nearly equal parts in point of horizontal extent." My powerful reflector exhibits with ease the curious vertical gullies which cut down for a short distance the inner

slope just above its junction with the floor; they are readily seen N. and S., but are most evident on the former side: landslips from above may probably explain them.—As to Full Moon markings, I find only the following: 1855, Aug. 27, "The appearance of the ring is encroached upon by a grey bay on S.S.W. side."—1855, Oct. 24 (a little before total eclipse), "While none of *Tycho's* streaks reach the foot of his wall, it is remarkable that *Copernicus* is penetrated even to the centre by several of his; two distinctly on the W. side, and one or two, not so well made out, on the N. The former look almost like a prolongation of the system of *Kepler*, as if *Copernicus* had pierced through, or been pierced through by it." (From some such observations, of which he has given no detail, Nichol assigned the chronological sequence, *Copernicus*, *Aristarchus*, *Kepler*. However this may be, it is not easy to interpret the development of a different shading, frequently taking the appearance of a definite patch or stain, among matter not only forced from beneath, but subjected to the most violent dislocation. If not due to original difference of material, it points to subsequent modification either from within or without. There seem reasons for doubting the former cause, as well-defined dark spots are occasionally met with where, as we suppose, the materials have been so dislocated that any original distinction could not have been so clearly maintained.)

The bare results of these rough studies might have been given in a briefer compass, but, in the original form, there may be some interest and some advantage to the inexperienced student. He may thus perceive what apparent variations may be produced by a slight difference in illumination, how unsafe are inferences from single observations, and how discrepancies are to be reconciled, if at all, by repeated examination. With a little more of the advantges of leisure, these memoranda might have been presented in a less fragmentary form, especially since the mirror now in my possession gives results far in advance of almost any hitherto published (and indeed the same might be said of smaller apertures of the same accurate workmanship). But even these may answer a good end by stimulating curiosity, and showing in what direction it may be suitably exercised.

Before finally quitting the neighbourhood of *Copernicus*, it may be well to make some addition from the observations of B. and M. The next crater of any size S.S.W. of the mighty monarch of the district, is *Gambart*, a circle, 16 miles across, but neither high nor deep. In this direction lies a large insulated accumulation of short ridges, trending the same way, the highest lying in a line from *Copernicus* to that crater. They are more connected, but less elevated, on the W. of the

centre of that line, where they form a nearly equilateral triangle, with one angle N. The N.W. side of this area is bordered by a long dark valley, extending S.W. 37 miles, and dividing it from a system of small parallel chains, whose highest summit, ζ, attains about 2600 feet. This mountain, already mentioned in p. 371 of our last number, must be looked for just S.S.W. of the little but conspicuous crater c, the only one at once S.W. of *Copernicus* and S.E. of *Stadius*; it must also stand very near the N.E. end of the bright streak which divides *Rhæticus* in the Full Moon (p. 216, *antea*). Of the parallel ridges they say, "these mountains are very dark, and here, in the Full Moon, a large blackish spot shows itself," in which they are unconsciously describing the W. part of their vainly-sought *Rhæticus* of Riccioli, the other portion seeming to be the "long dark valley" just described. There appears little doubt that in this parallelism may be found the "rampart-work" of Gruithuisen, the regular arrangement of which would probably repay a search; at the other end of the streak dividing *Rhæticus*, and consequently near the S.W. angle of their hill-triangle to the E. of it, they place a little summit ε. They remark that while the dark mountains continue so in full illumination, the triangle is brighter, 3° to 3½° of light, and ε has "exclusively a brilliancy of 7°, which it does not lose even in the neighbourhood of the terminator, an anomaly which is so much the more remarkable because it otherwise is not distinguished, either through form or elevation, from the rest, several of which overtop it." I regret that I did not notice this curious passage in time to compare it with the existing state of reflective power, but I have no recollection of such a spot when I was identifying *Rhæticus*, the notices of which are strangely scattered about in B. & M., and it must be left as an interesting subject of research for some of our readers.

E. of *Gambart* is a bright (8°) and conspicuous little crater A.

Reinhold (our 31) is a crater 31 miles in diameter, with strong terraces and a central hill at the N. end of a little ridge. The W. side of the ring is 9400ft., the E. 7000ft. above the interior. Schr. gives the former measure 8700ft., and makes the external height of the E. wall 1900ft. A mountain-ridge connects it with *Copernicus*, bending, as it were, round both the rings.

N.E. of *Copernicus*, we find a lofty tract which B. and M. call *Mt. Carpathus*, extending with its dependencies from E. to W. 280 miles. It includes *Gay Lussac*, a double crater already described in our p. 370: the smaller basin A is deeper, steeper, and brighter than its broader, and apparently more

ancient neighbour; a relation frequently obtaining in these configurations. Close S.E. of it our guides notice a dark spot in the Full Moon; an exemplification of our recent remarks. The ring of *Gay Lussac* is interrupted by a minute crater close to the companion-crater A; and they point out a curious arrangement here: three pairs of objects—A and this little pit—two summits (α) close together on the N.W. slope of the ring—and two others (β) on the E., make up respectively two equilateral triangles, with sides parallel and very close together, whose common centre coincides with that of *Gay Lussac* itself. The cleft proceeding from it has already passed under our review. The mountains E. are confused in arrangement, with no central axis; and are penetrated by valleys usually as luminous as the heights. Measurement is difficult from the way in which the shadows fall. One high promontory reaches 6300ft. Towards the E. extremity lies a considerable crater, *Tobias Mayer*, 22 miles in diameter. A summit of its W. ring rises 9700ft. above the cavity. Schr. pointed out that in consequence of its position on the mountain's flank, its E. side was much lower—he gave it but 2700ft. (short measure). It has a central hill, which from local colour appears large in Full Moon. S.E. of this the map shows a very minute crater in the depth; rather an unusual position. W. of the ring lies a conspicuous *sub-crater*, as it might perhaps be termed, *Mayer* a. The extremity of the mountains N.E. of *Mayer* rises to 4000ft.—*Milichius*, a small bright (8°) crater lies in a curiously-shaded region of the *M. Imbrium* (I), nearly S. of *Mayer* and E. of *Copernicus*. S.S.E. of this is another similar crater, *Hortensius*, very remarkable for its isolation, and the luminosity surrounding it, almost like a miniature streak-system. In a position forming a right-angled triangle with the two last objects—the right angle being towards *Copernicus*—is a spot containing within the compass of less than 30 miles eight parallel ridges running nearly N. and S., and all pretty nearly of similar length and elevation.

Another step S.W. brings us from *Hortensius* to *Reinhold* again, and completes the circuit of a region where so much is seen, and so little is understood, of the wonderful works of God.

TRANSITS OF JUPITER'S SATELLITES.

Jan. 1st. I. egress, 5h. 11m.—Ditto shadow, 6h. 16m.—5th. II. shadow ingress, 5h. 50m. II. egress, 6h. 34m.—8th. I. shadow ingress, 5h. 53m. I. egress, 7h. 12m.—12th. II. ingress, 6h. 29m.—15th. I. ingress, 6h. 54m.—24th. I. egress, 5h. 45m.—Ditto shadow, 6h. 31m.—30th. II. shadow egress, 5h. 45m.—31st. I. shadow ingress, 6h. 8m.

OCCULTATIONS.

Jan. 6th. 48 Tauri, 6 mag. 9h. 20m. to 10h. 24m. γ Tauri, 4 mag. 11h. 28m. to 12h. 33m.—30th. *f* Piscium, 6 mag. 9h. 56m. to 10h. 26m.

OUR FRESH-WATER PLANARIÆ.

BY W. HOUGHTON, M.A., F.L.S.

(With a Plate.)

ANYBODY who has occasionally gathered water-cress, or searched amongst aquatic weeds for objects for the aquarium, must be acquainted with certain small black or brown creatures, of an oblong form when at rest, soft, smooth, and flat, and about five lines in length and one and a half broad. These are two species, or, it may be, two varieties only, of Planarian worms. Probably the collector of objects for the aquarium sees in these animated black blotches very little to attract his attention, and he throws them aside; or if curiosity tempts him to bottle a few specimens for examination, he finds that he is able to make out very little of their structure, and sees scarcely anything to interest him in their habits; and certainly when we compare these fresh-water *Planariæ* with other rare and exquisite forms of animal life, such a *Cristatella*, *Fredericella* or *Plumatella* amongst our fresh-water Polyzoa, or a *Melicerta* or a *Stephanoceros* amongst the *Rotatoria*, these little black dabs have small claims to beauty; nevertheless the large white species, *Planaria lactea*, with the pink arborescent ramifications of its digestive system, is by no means devoid of beauty, whilst the commoner black or brown kinds present many points of interest to the naturalist, both in their habits and anatomy. The *Planariæ*, as their name imports, are of a flattened form; the under surface of some of the species bears some resemblance to the foot of a gastropodous mollusc. In many parts of their organization the *Planariæ* resemble the Flukes which inhabit the liver and other viscera of various animals, especially ruminants; but none of the *Planariæ* are internal parasites, nor do they, like the Flukes, undergo a metamorphosis. They inhabit fresh and salt water, and are to be found on the leaves and stems of aquatic plants, and amongst the roots of the *Laminariæ*, between tide marks. On the present occasion I shall confine my remarks to the fresh-water species, of which a great number have been described as occurring in France by Dugès who has published two very interesting memoirs on these animals.* In this country also,

* See "Annales des Sciences Naturelles," Tom. xv. and Tom. xxi.

several kinds are found, of which *Planaria lactea, P. torva, Polycelis nigra, P. brunnea* are common everywhere in ponds, streams, and ditches. A favourite place of resort of these creatures is within the stems of *Sparganium*, whence they may be readily picked or scraped off with the point of a knife and placed in a bottle of water. Difficulties of dissection long prevented naturalists assigning to the *Planariæ* their true place in the animal kingdom; Cuvier, following Müller, Linnæus, Pallas, and Lamark, placed them amongst the parenchymatous *Intestinalia*, or *Trematode Entozoa* (as the Flukes *Distoma*), acknowledging at the same time their resemblance to certain species of the *Hirudinidæ* or leech family. The *Planariæ* have affinities with both these families, and lead from one to the other. Let us suppose we have under examination the largest of the British fresh-water *Planariæ*, viz: *P. lactea;* this species varies a little in colour, which is either cream, roseate, or quite white; it is from six to ten lines in length, and about two lines in breadth; we first notice the delicate arborescent form of the digestive system; we place the creature on a glass slide and hold it up to the light, in its middle part we see a milk white spot which extends linearly towards the posterior extremity; by allowing the water gradually to evaporate, the animal shows signs of discomfort, and we observe a long cylindrical tube to be pushed out from a pore slightly posterior to the middle of the body: this pore is the mouth, and the tube is the proboscis, a formidable instrument of attack in these creatures; we notice two black oculiform spots, parallel, and placed on the anterior part of the back; a little below the oral aperture we see, but very indistinctly in *P. lactea*, another pore which belongs to the generative system; we find the body to be slimy, very soft, and readily breaking up if not handled with great care. Let us take another specimen of the same species, and with the aid of a camel's hair pencil, place it gently in a vessel of water, and observe its locomotive powers; we see it gliding in an even and regular manner, like a *limax*, or slug; if we touch it, the animal twists itself in various folds, or it fixes its head portion to the vessel, and, by contracting, brings the other parts of the body along, then the posterior part is attached, and the head portion elongates and advances. In the species *Polycelis nigra, P. brunnea, Planaria torva*, we observe the gliding locomotion to be frequently exercised on the surface of the water, the ventral side of the animals being uppermost; none of the true fresh-water *Planariæ* can be said to swim; but an allied marine species, *Leptoplana tremellaris*, progresses by flapping its sides as a Ray its fins.* When we consider how varied and energetic are the movements of the

*Dugès "Annal. des Sciences, Nat." xv. 151.

Planarian worms, for they can contract and elongate their bodies, fold themselves together in various forms, and unfold themselves, we naturally expect to find the presence of muscular fibres; how can such movements be explained except by the admission of the existence of a muscular system? And yet there are some animals of low organization, such as the small species of the *Trematoda*, which are endowed with active contractility, in whose bodies, notwithstanding, no muscular fibres have been detected. With respect to the *Planariæ* many observers, as de Blainville, Dugès and others, entirely deny the existence of a muscular system, except in the proboscis, and genital organs; M. Quatrefages, on the other hand, describes a sub-cutaneous plane of muscular fibre, as being recognisable in some species, and Professor Owen remarks that in the *Planariæ*, in which as in the *Tæniæ*, according to his observations, the muscular system is indicated only by the striæ on the superfices of the apparently homogeneous parenchyma, the phenomena of muscularity are strikingly displayed in the varied and energetic actions of the living animal.* My own investigations have satisfied me of the existence of a sub-cutaneous plane of loose muscular fibre in the fresh-water genera, *Planaria* and *Polycelis*. A nervous system in some species has been recognised by de Quatrefages, who describes it as "consisting of two ganglions, more or less intimately united, which are situated in the mesial line, near the anterior part of the body. This double ganglion, which may be called the brain, and which is sometimes visible to the naked eye, is lodged in a special lacuna or cavity, recognisable from its transparent outline, and is seen to give off nervous filaments in various directions to different parts of the body."† In vain have I laboured in search of the faintest indications of a nervous system in the species I have examined. The relation of the *Planariæ* to the Flukes, as already noticed, might lead us to expect the existence of a rudimentary nervous system in them as in those Entozoa, nevertheless, I think that we must still consider its presence in the fresh-water species as a subject requiring verification. Professor Rolleston, who, at my request, kindly repeated his examination of many specimens of *Planaria lactea*, says, "With reference to the nervous system of this species, I have never been quite satisfied that it was a real existent thing. Leydig says he has failed to see it sometimes in the fresh-water *Planariæ*; but that the analogy of the marine *Planariæ*, where a nerve-system is undoubtedly present, has forced him to look for it, and that he believes that a couple of pear-shaped ganglia underlying the two eyes, and

* Todd's "Cyl. of Anat." ii., p. 128.
† Rymer Jones, "General Structure," p. 146.

figured by him, really exist, and are the nerve-system. At page 139 of his Handbook, he says he has not been able to see any commissure connecting these two ganglia in *P. lactea*. I looked into the matter in the summer, and have since my return to Oxford, on the receipt of your note, looked into it again. I had written as follows for my book in the summer: speaking of the 'anterior cœcal end of the intestine passing up between the two eyes, and underlaid in the marine genera allied to this by a nervous band, passing from the ganglia in relation with the eyes. According to Schmidt and Schultze ("Zeitschr. Wiss. Zool., x. Taf. iii. fig. 1), the same is the case in the fresh-water *Planariæ*. Of this, however, it is difficult to convince one's self, with the semi-transparent species, *Dendrocœlum lacteum*, which is very closely allied to this.' On further investigation I see no reason to alter this." In a subsequent letter the Professor writes that "between the cœcal ends of the intestinal tree-branches and the eyes, I saw a number of large cells with hyaline contents and a centrally-placed granular nucleus. These cells, I take it, are the nerve ganglia, loosely apposed cells making up the nerve ganglia in some of the anneloids, at least if we rank Echinodermata under this head. But I saw no commissure connecting these aggregations of cells." But whatever may be the truth with respect to a nerve-system, the *Planariæ* are certainly sensitive, the *P. lactea* particularly so; they are fidgetty under condensed light, especially when applied to the head; when touched with the point of a needle, or when pierced by the proboscis of one of its own kin, as by *Polycelis brunnea*, the large *Planaria lactea*, evinces by its contortions, an undoubted sensibility. Living almost exclusively in shaded habitations, the *Planariæ* cannot be expected to possess visual organs of much complexity, but there seems no reason to doubt that the oculiform spots, which vary from two to fifty, according to the species, do in some degree perform the function of eyes.

Let us now examine the digestive system of a Planarian worm.—The mouth in the true *Planariæ*, as has been already stated, lies on the ventral surface, a little below the centre of the body; it is a circular aperture, through which the muscular contractile œsophagus, or tube, is protuded, whether for the purpose of feeding or for defecation. In form this proboscis is chiefly cylindrical, as in all the fresh-water species. In the marine *Leptoplana tremellaris*, it is infundibuliform, and gracefully waved. The proboscis can be protruded to a considerable length; according to Dugès, it consists of two tunics, the external one being formed of longitudinal, the inner one of circular fibres, and it is to the peristaltic constrictions of this inner tunic that the mechanism

of suction is due, and the passage of nutritious particles into the ramifications of the stomach and digestive apparatus. It is most curious to watch the movements of a planarian proboscis when forcibly detached from the body of the worm; it almost seems to enjoy a separate existence for a time; it may be seen to open the orifice and swallow the pulpous particles of its own body, then by contracting, to eject them through the other end. This tube is in contact with the stomach and digestive system, and opens out into it; its basilar portion being apparently connected with the stomachal walls by a very thin transparent membrane, very easily ruptured. The digesive apparatus in the true *Planariæ* consists of a number of arborescent ramifications; there are three principal trunks, which unite about the centre of the body and receive the particles of food supplied them by the proboscis; one of these trunks proceeds in a direct line upwards towards the head, along the mesial line of the body, and from it on either side there are numerous branched cœcal appendages; the other branches immediately diverge and pass down the sides of the body, again converging towards the posterior extremity. This arrangement is very apparent in *Planaria lactea*, in which the cœcal appendages are most numerous; in the other species, owing to the opacity of the body, it is not so readily seen; slight pressure with the compressorium, however, reveals a similar structure. The food of the *Planariæ* consists of infusorial animalcules, small naïd worms, the blood of which they suck, sometimes, according to Dugès, without perceptibly piercing their skins. The same observer states that animalcules of the family *Cyclidina* are sometimes found alive in their digestive organs. That they have, however, cannibal propensities and devour each other, I have myself frequently witnessed; this character, according to my own observations, belongs more especially to the species *Polycelis nigra*, and *P. brunnea;* it is curious to see the rapidity with which one of these fellows bores a hole into the body of one of the large *Planaria lactea*, and crumbles him into his component particles. The attacking enemy throws his body in a fold over some portion of its victim, and immediately begins to bore into him with his proboscis; this boring very soon reduces a part of the body of the victim into minute particles which are sucked up by the proboscis, as it makes its way along. The *Planariæ*, like the parasite *Trematoda*, are destitute of an anus, the undigested portion of their food being regurgitated through the suctorius tube.

The circulation in these animals is described as consisting of a mesial and dorsal canal and two lateral vessels, from which proceed in all directions, a fine cutaneous network of minute

nutrient vessels, which issue from the extremities of the intestinal cœca. Dugès says the circulation is best seen in *Polycelis nigra*, and *P. brunnea*, and in the marine *Leptoplana tremellaris*. I confess that notwithstanding the most patient observations, I have not yet been able to make out completely the circulation in these worms; young specimens, from their comparative transparency, I thought would readily show it, but I have been disappointed in my examinations.* The circulation is readily enough seen in the equally small species of snail-leeches (*Glossophonidæ*); why it should be so difficult to make out in the *Planariæ* I cannot tell, but Dugès is so trustworthy an authority, that one is not inclined to dispute his statements. The mesial dorsal trunk in *P. nigra* and *P. brunnea* is described by him as being tortuous and narrow, sometimes more difficult than at other times to make out, on account, no doubt, he adds, of its dilating and contracting; the same systole and diastole may also be noticed in the lateral vessels. This arrangement of the circulation in the *Planariæ* reminds one of that of the leeches.

Of the respiration little need be said. The circulating fluid is oxygenated by the air contained in the water over the whole surface of the body, the numerous minute cilia which clothe the margin of the body, helping to bring fresh currents. *Planariæ* require a constant renewal of water, if kept many together in a vessel, or they soon die.†

The *Planariæ* exhibit the phenomena of reproducing lost parts, almost emulating, in this respect, the *Hydræ*. Sir John Dalyell says of the black *Planaria* (*Polycelis nigra*), that "it is privileged to multiply its species in proportion to the violence offered to its otherwise delicate frame. It may be almost called immortal under the edge of the knife. Innumerable sections of the body all become complete and perfect animals. If the head be cut off, a new head replaces it; if the tail be severed, a new tail is acquired." Dugès experimented considerably, and with the same result as Dalyell. An individual cut into eight or ten parts produced the same number of complete animals. The time required to reproduce a lost part depends on the time of year—fourteen or fifteen days being required in winter, four or five in summer. The species also differ in this respect. This reproduction by division appears to take place sometimes

* The only point of the circulation I have distinctly seen, occurred in a specimen of *P. lactea*. I noticed various ramifications of the water-vascular system in the regions of the eyes, under ¼″ objective, but could see no dorsal or lateral channels.

† They can, however, bear extreme cold without being killed. I have some specimens of *P. torva* and *Polycelis nigra* which have been frozen in a tumbler of water during the last frost. They are now as active as ever. Some of these specimens were not more than two lines long, and about six weeks old.

naturally, as in the *Vorticellæ* and other *Infusoria*. Müller noticed it in *P. ciliata*, Dugès in *Derostoma leucopta*, Otto Fabricius in *P. vulgaris*. Draparnaud and Dugès saw it several times in *P. tentaculata*. I have frequently experimented myself in this way, and have seen these creatures reproduce lost halves, or segments; but on chopping them into eight or ten parts, I have always found they died, doubtless from some causes not favourable to reproduction. An individual divided in a longitudinal fissure at the head will often exhibit the phenomena of two heads. *Planariæ* propagate by mutual contact, as in other animals; they are androgynous; and no doubt the presence of two individuals is necessary for the procreative act. Dugès has witnessed the copulation in *P. torva*, and recently I have noticed it in the same species. According to the researches of Dugès, "the male organ consists of two parts, one of which is free, smooth, semi-transparent, contractile, and always divided into two portions by a circular constriction; it is traversed by a central canal, susceptible of being dilated into a vesicle, and is open at its free extremity, which is turned backwards; the second division is thicker, more opaque, vesicular, adherent to the contiguous parenchyma, and receives two flexuous spermatic canals. The free portion of this organ is contained within a cylindrical muscular sheath, which is adherent to the circumference of the base of the intermittent organ, and serves to protrude it externally. This sheath communicates with the terminal sac of the female apparatus near its outlet by a projecting orifice. The oviduct opens into the posterior part of the terminal sac; it is a narrow tube which passes directly backwards, and dividing into two equal branches, again subdivides, and ramifies amongst the branches of the dendritic digestive organ. Besides the ovary, there are two accessory vesicles, communicating together by a narrow duct, and opening into the terminal generative sac." The *Planariæ* lay round or ovoid eggs, with a horny covering, containing three or four young ones. These cases are of a reddish colour, and may be found in numbers deposited singly on the leaves of aquatic plants, especially within the stems of *Sparganium*. I believe the young ones issue from the capsules in eight or nine days after they have been laid; the young ones are minute and drab-coloured, about a line long; they exactly resemble the parents, both in form and manner of life; they grow rapidly where the water is fresh and the food plentiful.*

* Other modes of propagation have been observed to take place in some of the *Turbellariæ*, as by internal budding, or the young are at first larvæ unlike their parents. Professor Agassiz once thought that certain infusoria, as *Paramecium* and *Kolpoda*, were Planarian larvæ; but the researches of Balbiani have

Planariæ soon die when taken out of the water, a drop of spirits of wine or other alcohol, kills them instantaneously and renders their bodies hard; vinegar softens but does not dissolve them.

The *Planariæ* belongs to the order *Turbellaria*, whose characters are thus given by Dr. Johnston: "Worms individual, locomotive, very rarely tubicolous, monœcious, or diœcious, with or without eyes, the surface usually coloured, and sometimes in elegant patterns, transparent or opaque. Body soft, parenchymatous or cavernous, flat or sub-cylindrical, naked and lubricous, covered more or less with vibratile cilia, and sometimes with papillæ, often very contractile, and polymorphous, and sometimes breaking up voluntarily into pieces, head continuing with the body, or rarely, imperfectly defined, either without tentacula, or with two frontal or dorsal ones prolonged from the surface. Mouth either terminal or ventral, and in the latter case situated in the anterior third, or near the centre, or towards the tail; often furnished with a prehensile proboscis. Intestine dendritically branched, or undivided, with or without an anus. Zoophagous, but some appear to feed, occasionally at least, on decaying plants. Oviparous, or viviparous, very rarely multiplying by spontaneous division. There are no suckers or discs, and progression is made by gliding or by natation. They are never internal parasites, but tenant fresh and salt water, and are found sometimes in moist places. The skin is very rarely iridescent, and there is no phosphorescent species."

As Dr. Johnston's book* is probably in the hands of only a few readers it may be well to give here his classification of the British genera. The order *Turbellaria* he divides into two sub-orders, viz. I. *Planarica* and II. *Teretularia*. The first order alone concerns us at present; it is thus defined:—

"The body, parenchymatous, flat, or flattened, usually only a little longer than broad, acephalous, with or without eyes on the dorsum in front. Mouth, a simple pore, often the aperture to a prehensile proboscis. Anus, none. Genital pore, posterior to the oval." This sub-order, *Planariea*, is divided into three families, with their respective genera, as follows:—

negatived that idea. Whether the fresh-water *Dendrocœls* or *Rhabdocœls* ever go through a larval condition I know not. I have hatched scores, and always noticed that the young exactly resembled their parents.

* I am well aware that Dr. Johnston's catalogue of British non-parasitic worms is far from complete; nevertheless, as it is the only English text book on the subject, and the work of a very accomplished naturalist, I have preferred in this paper to retain it. It must be confessed that at present the subject of the Planarian worms and other *Turbellaria* is involved in obscurity. Identification of species is difficult. Young specimen have, it is probable, been sometimes taken as distinct species.

* *Intestine dendritically branched.*

Family I.—PLANOCERIDÆ. Flat: the mouth nearly in the centre of the ventral surface, and furnished with a short proboscis, crenated or lobed at the orifice.

1.—*Leptoplana*. Multocular, the eyes clustered: no tentacula.

2.—*Eurylepta*. Multocular, the eyes clustered: two frontal tentacula.

3.—*Planocera*. Multocular, or eyless: two dorsal tentacula.

Family II.—PLANARIADÆ. Flattish: the mouth inferior, sub-central, with a long cylindrical proboscis, plain at the orifice.

4.—*Polycelis*. Eyes, many, in a marginal series.

5.—*Planaria*. Eyes, two; dorsal and paired.

** *Intestine an undivided tube.*

Family III.—DALYELLIDÆ. Mouth terminal, or sub-central, eproboscidean.

† Eyes, two.

6.—*Dalyellia*. Mouth, terminal.

7.—*Derostoma*. Mouth, ventral, anterior.

8.—*Mesostoma*. Mouth, ventral, sub-central.

‡ *Eyeless.*

9.—*Opistomum*. Body, elongate; mouth terminal.

10.—*Typhloplana*. Body, linear-oblong: mouth ventral, sub-central.

11.—*Convoluta*. Body, involute.

In the PLANOCERIDÆ, the body is thin, flat, and laterally expanded; the eyes when present, are clustered. The oral aperture is usually closed, and becomes almost indistinguishable, but the position of it, and of the proboscis, is marked by an oblong spot, near the middle of the ventral surface. This is always paler than the dorsal, which is commonly beautifully coloured. The motion is slow. The food is soft, either the juices of invertebrate animals, or the parenchyma of decaying algæ. All are marine, and propagate, probably, by naked cilated ova, undergoing no metamorphosis. In decay the body is diffluent, and decomposition has far advanced before life is extinguished. The species *Leptoplana tremellaris* and *Eurylepta vittata*, with its sinuated margin, and dotted,

ear-shaped tentacles, are probably familiar to many sea-side explorers, being not uncommon under stones, and within the tangled roots of laminaria, but our business is with the fresh-water, and not the marine species.

The *Planariadæ* contain the species of true *Planariæ*; and, as I have already given my observations upon them, there is no necessity to define the family again. It consists of two genera, *Polycelis* and *Planaria*, the chief characteristic distinctions between them being that *Polycelis* has numerous oculiform spots of a black colour, bordering the anterior margin of the animal; these spots extend to about a third of the length of the animal; whilst *Planaria* has two eyes, nearly parallel, situated on the back of the head.

Of the genus *Polycelis*, Dr. Johnston enumerates three British species, viz: *P. nigra*, *P. brunnea*, and *P. felina*. The two first are considered by some naturalists to be merely varieties; I am rather inclined to regard them as specifically distinct. *P. nigra* is extremely common in ponds and ditches; it is evidently the "limace aquatique noire," portions of which little creature Trembley used sometimes to treat his favourite hydræ with. The body is depressed, even, and very smooth; of a black velvet colour. Of an oval form when at rest: linear-oblong when moving. The head is slightly sinuated with a central projection in front, and two marginal ones: this is seen only when the creature is in motion; the oval proboscis is long, white, and cylindrical, with a plain but dilatable orifice; length, when extended, about five lines, and one and a half broad.

P. brunnea does not differ, perceptibly, from *P. nigra*, except in colour, which is a smoky-brown, with a dark mesial line very distinct; it is as common as the black species. *P. felina* which, like the last named kind, is regarded by Diesing only as a variety of *P. nigra*, is described as being linear-oblong in form, minutely tricuspidate in front, of a uniform dark brown, paler underneath, and eight lines long by one and a half broad. I do not know the species; it appears to be the *Planarian viganensis* of Dugès; and from the decidedly auricular form of the head, to judge from Dugès figure, ought perhaps, to be considered a distinct species. It inhabits stagnant waters, in which aquatic vegetables abound, and rarely is found in springs. Of the genus *Planaria*, Dr. Johnston enumerates four British fresh-water species, viz: *P. lactea*, *P. torva*, *P. Arethusa*, and *P. Edinensis*. The first named species is white or pinkish, and shows most clearly the dendritic cavity of the digestive system. When moving it is of an oblong form, the front truncate, a little auricled on each side; but it assumes various forms, and frequently sinuates its

margins in elegant folds. The normal number of eyes is two, but there are occasionally four, in which case the anterior pair is very minute. Dr. Johnston says it inhabits cold springs and lakes, is gregarious, and not common. I find it in the canal near my house, and in pools in the neighbourhood, tolerably abundant, and have never any difficulty in procuring specimens for examination. I do not consider it more gregarious than other species.

P. torva. This is a very quaint looking fellow; its two black eyes, which are of a crescent form, are partly surrounded by a white ring or halo, which gives the creature a squint-like look: suggesting, probably from its sinister appearance, a disposition conveyed by the epithet, "torva." It is described as being cinereous or black, on the dorsal, and greyish on the ventral surface. The front is obtuse, rounded on the angles, and projecting in the centre. It deposits a large oval capsule, and is six or seven lines long, by about two broad.

I have recently met with some very large velvety-black *Planariæ*, which resemble *P. torva*, in having a white halo round the eye-spots; but I have reason for believing that they are individually of a distinct species. The black eye-specks in the surrounding uncoloured halo are not visible under a simple lens in the individuals I am speaking of; but the compound microscope of about twenty diameters reveals them. In *P. torva*, the eye-specks are very apparent under a simple lens: the colour is of a decided black when viewed by reflected light; in size it is almost equal to the large *P. lactea*, and it often crenulates its margins like it, but only very slightly. I do not find any other *Planariæ* like the ordinary *P. torva* in the water whence I obtain these large individuals, and I am inclined to regard them as, if not a distinct species, at any rate a well-marked variety. I have occasionally found a *P. torva* with four eyes, each pair with the characteristic white halo; the anterior ones in this case are small, as in *P. lactea* when possessed of four eyes. I have little doubt that this four-eyed variety of *P. torva* is the *Tetracelis fontana* of Diesing ("Systema Helminthum," i., p. 191), who thus describes it:—"Corpus depressum ellipticum, antice truncatum, fuscum. Ocelli geminati nigri in macula alba, postici reniformes majores. Longit. 6‴, latit. $1\frac{1}{2}$‴."

P. Arethusa is described as being truncate and auriculate in front, leaden or slate grey, paler underneath, having a black eye on a white spot on each side of the medial line in front. Length, six lines; breadth, one line. It is said to be common in pure springs and rivulets. I do not know this species.

P. Edinensis inhabits pure springs, and is rare. It is the smallest of the fresh-water *Planariæ*, being only three lines

long and one broad; it is linear oblong, and rather narrowish in front, of a pale carnation, head obtuse, rose colour; eyes nearly marginal in the rose-coloured part. It has been found in the neighbourhood of Edinburgh, as its specific name implies, by Dalyell, Flemming, and Johnston. I have never seen this species.

The family of *Dalyellidæ*,* so called after Sir John Dalyell, who has paid much attention to these creatures, containing six genera, five of which are lacustrine, differs from the foregoing groups, in all its members having the intestine an undivided tube. "They are small animals, of a parenchymatous consistency, in which it is often difficult to trace any distinctly defined viscera, or their openings on the surface. The body is acephalous, and more or less contractile, with an entire margin. They are either marine or lacustrine; and the latter, in general, lay their eggs enclosed in a cocoon or capsule. Of the mode in which the marine genera are propagated, nothing appears to be known." The fresh-water genera are defined severally as follows:—

(1.) *Dalyellia.* Body somewhat compressed vertically, elliptical; the mouth terminal; eyes two, parallel, posterior to the mouth and dorsal; ova capsulated. Lacustrine. Dr. Johnston describes two British species, viz.:—*Dalyellia helluo*, which is narrowed at both ends, most so posteriorly, of a uniform grass-green colour, with a transparent margin, one to one and a half lines long, inhabiting stagnant waters; and *D. exigua*, which in motion resembles a double cone in form, reddish in colour, one-third of a line in length, and an inhabitant of ponds. The first species has been described by several naturalists; the second was first noticed by Sir John Dalyell. I am unacquainted with both.

(2.) *Derostoma.* Body linear-oblong, rounded at both ends, with two eyes or none; mouth pitcher-shaped, concealed, opening by a longitudinal fissure on the venter. Two British species are described, viz., *D. unipunctatum*, which is plump, narrowed towards the anterior extremity, and obtuse behind, dingy yellow, with two yellow eyes, and three lines long, an inhabitant of ponds with a muddy bottom; and *D. vorax*, with round body, obtuse in front, tapering backwards to a point, greenish, and without eyes. It is one and a half lines in length, and is found in fresh-water marshes. The generic name, which signifies "long-mouth," from its longitudinal opening, was proposed by G. Dugès in 1828.

* The Planarian worms have been well divided into the two following sections:—

(1.) DENDROCŒLS, having a digestive apparatus dendritically branched.

(2.) RHABDOCŒLS, having a straight or unbranched digestive apparatus.

(3.) *Mesostoma.* Body somewhat flattened when at rest; the mouth ventral, sub-central, encircled with a broad annular sphincter; eyes two approximate, on the dorsum behind the apex and anterior to the mouth. Lacustrine. The ova capsulated. Dr. Johnston describes one species only, viz., *M. rostratum.* It is elongate, elliptical, acuminate, and alike at both ends, whitish and pellucid, or tinted a yellowish-red; eyes reddish or black, approximate; mouth central; egg capsules dark brown or reddish, length three lines, breadth half a line. This little animal I find quite common within the stems of *Sparganium*, but owing to its small size and pellucid appearance very easily overlooked. The reddish colour, of which Dr. Johnston speaks, is owing to a number of red capsulated ova often seen within the body of the animal; I have occasionally counted as many as twenty-five or thirty. The proboscis, or œsophagus, is bulbous in form, with five or six strong radiating muscles (see Fig. 6). It glides along the surface of submerged bodies and moves rapidly in the water, which appears to have suggested the epithet *Velox* to Dr. Johnston. I believe the animal dies immediately after laying its eggs. Another species (Fig. 10), the *M. personatum* of Dr. Oscar Schmidt, I have found in a reedy pond, near Preston on the Wild Moors, Salop. I have recently added it to the British fauna. See Ann. and Mag. Nat. Hist. for last December.

(4.) *Opistomum.* Body flattish, with an anterior sub-terminal mouth; the œsophagus pitcher shaped, not protrusile; eyes, none. Lacustrine. One British species only has been described, viz., *O. serpentina*, which is tongue-shaped, dilated and rounded in front, lanceolate behind, white or grey, two lines in length, and an inhabitant of fresh-water pools. Sir J. Dalyell found this little animal, and on his authority, it is added to the British fauna. It appears, from the description, to be identical with the *Opistomum pallidum* of Schimdt. It is unknown to me.

(5.) *Typhloplana.* Body oblong, somewhat roundish; head continous with body; mouth sub-central, a little posterior to the middle of the body; eyes, none. Lacustrine. Two British species are enumerated in Dr. Johnston's catalogue, *T. fœcunda* and *T. prasina.* The first is nearly linear, or a little swollen at the middle, with obtusely rounded extremities, white, and half a line in length; it is found in ponds in autumn. The second is grass-green in colour, obtuse in front, tapering to a point behind; it is gregarious, and is found in ponds in autumn. Both are minute species, about half a line in length. I am not acquainted with either of these species. The species belonging to the genus *Convoluta*, being marine, do not come within the scope of our inquiries.

The above descriptions of these *Planarian* worms, partly taken from my own observations and partly from Dr. Johnston's catalogue, will, I hope, be found of use in helping some of my readers to determine the species they may meet with. The works I have consulted on this subject are Dugès two valuable memoirs, Diesing's "Systema Helminthum," O. F. Müller's "Vermium Terrestrium et Fluviatilium," the "Prodromus Zoologiæ Danicæ" of the same author; Oersted's "Entrouof Plattwürmer;" Professor Owen's artice on Entozoa in "Todd's Cyclopædia of Anatomy," and Dr. Johnston's "Catalogue of the British Non-Parasitical Worms in the Collection of the British Museum," published by Taylor and Francis in 1865. The large work of Müller, "Zoologia Danica," contains several figures of the *Planariæ*, as also does Sir John Dalyell's work, "The Powers of the Creator Displayed in the Creation," published by Van Voorst. The former work I have not seen, the figures in the latter are not very good. There is also a treatise by Dalyell, "Observations on the Planarian Worms." Dr. O. Schmidt's Treatise ("Die Rhabdocœlen Strudelwürmer") is the best work on the fresh-water *Rhabdocœls*. It contains numerous figures of these animals. The researches of the same author on the sexual organs of the *Dendrocœl Planaria*, in the "Zeitschrift für Wissenschaftliche Zoologie," Band. x. and xi., must be especially mentioned, but I regret I was unable to consult the volumes at the time I was investigating the anatomy of these worms, neither have I been able to meet with Schultze's "Bertrüge zur Naturgeschchte der Turbellariea."

Description of Plate.

Fig. 1.—*Planaria lactea*, showing dendritic form of digestive system (after Dugès).

Fig. 2.—The same species, drawn from a living specimen.

Fig. 3.—Head of *P. torva*.

Fig. 4.—*Mesostoma rostrata*, as it progresses.

Fig. 5.—The same species when at rest.

Fig. 6.—Full and side view of proboscis of ditto (from specimen).

Fig. 7.—Head of *Polycelis brunnea*.

Fig. 8.—Capsulated ova of *Mesostoma rostrata*.

Fig. 9.—Ditto of *Planaria torva*.

Fig. 10.—*Mesostomum personatum* (from a specimen).

Fig. 11.—*Planaria torva*, with protruded proboscis, swallowing a worm (after Dugès).

Fig. 12.—The same, in another position, attacking a worm (after Dugès).

Fig. 13.—*Polycelis nigra*, progressing.

Fig. 14.—*Polycelis nigra*, at rest.

Fig. 15.—Reproductive organs of *P. lactea*. *a*, Penis and sheathe; *b*, oviduct; *c*, vesicle and reservoir of eggs; *d*, common orifice (after Dugès).

All the figures, except 11, 12, 13, and 14, are magnified.

THE GRAVE-MOUNDS OF DERBYSHIRE, AND THEIR CONTENTS.

BY LLEWELLYNN JEWITT, F.S.A., ETC., ETC.

(*Continued from page* 350.)

THE ANGLO-SAXON PERIOD.

The county of Derby fortunately affords abundant and unusually excellent, as well as remarkable, examples of the graves of the Anglo-Saxons, and therefore we need be at no loss in describing the modes of interment, and the objects which are found in the graves and in the barrows of this period. When it is recollected that one of the towns of Derbyshire—Repton (Hrepandune)—was the capital of the kingdom of Mercia and the burial-place of the Mercian kings; that the names of many other places are derived from their Saxon owners; and that one of the main roads used by them—and before their time by the Normans and the ancient Britons—the Ryknield Street, ran through the county, it will easily be seen that in the Saxon times Derbyshire was so well populated and so thriving, that the interments must have been not only numerous but of all kinds. Accordingly we find examples both of burial by cremation and of the unburnt body in cemeteries, as well as instances of interment having been made in the earlier Celtic barrows.

Generally speaking the Anglo-Saxon graves were rectangular cists or pits cut in the ground to the depth of from two or three to seven or eight feet. On the floor of this the body was placed at full length, on its back, in the dress which was worn by deceased when living. The arms were usually extended by the sides, with the hands resting on the pelvis. Around the body were placed articles which had been used, or were valued by, or which it was thought might be useful to, the deceased. The grave was then carefully filled, and a mound of but low altitude raised over it; the earth being generally "puddled" or tempered. This mound or hillock was called a

Hælw from which the Derbyshire name of *Low* is evidently derived. The accompanying plan of a grave opened by Mr. Bateman on Lapwing Hill, will pretty tolerably illustrate this mode of Anglo-Saxon burial. Beneath the bones of the skeleton were "traces of light-coloured hair, as if from a hide, resting upon a considerable quantity of decayed wood, indicating a plank of some thickness, or the bottom of a coffin. At the left of the body was a long and broad iron sword, enclosed in a sheath made of thin wood covered with ornamental leather. Under or by the hilt of the sword was a short iron knife; and a little way above the right shoulder were two small javelin heads, four-and-a-half inches long, of the same metal, which had lain so near each other as to become united by corrosion. Among the stones which filled the grave, and about a foot from the bottom, were many objects of corroded iron, including nine loops of hoop iron (as shown in the engraving) about an inch broad, which had been fixed to thick wood by long nails; eight staples or eyes which had been driven through a plank and clenched, and one or two other objects of more uncertain application, all which were dispersed at intervals round the corpse throughout the length of the grave, and which may therefore have been attached to a bier or coffin in which the deceased was conveyed to the grave from some distant place." Indications existed of the shield having been placed in its usual position over the centre of the body, but no umbone was in this instance found. The mounds are usually very low, frequently not being raised more than a foot above the natural surface of the ground. The earth was, as I have stated, usually "puddled" or tempered with water, and thus the body in the grave became closely imbedded in a compact and tenacious mass. That the tempering, or puddling, was accompanied with some corrosive preparation, there can be little doubt, for it is a fact, though a very remarkable one, that whilst the skeletons of the

Celtic period are found in good condition, and in some instances perfect and sound, those of the Anglo-Saxons have, almost invariably, entirely disappeared. Thus in a Celtic barrow the primary interment of that period may be found in perfect condition, while the secondary interment, that of the Anglo-Saxon, although some centuries later in date, and some three or four feet nearer the surface, will have decayed away and completely disappeared. Thus, in a barrow at Wyaston which had been raised over the body of a Saxon lady every indication of the body had disappeared with the exception of the enamel coating of the teeth, while a splendid necklace of beads, a silver ring, silver earrings, and a silver brooch or fibula, remained *in situ* where the flesh and bones had once been. Another instance (to which I shall have occasion again to allude) which may be named was the barrow at Benty Grange—a mound not more than two feet in elevation, but of considerable dimensions, and surrounded by a small fosse or trench, raised over the remains of a Saxon of high rank. In this mound, although a curious and unique helmet, the silver mountings of a leather drinking cup, some highly interesting and beautiful enamelled ornaments, and other objects, as well as indications of the garments, remained, not a vestige of the body, with the exception of some of the hair, was to be seen. The lovely and delicate form of the female and the form of the stalwart warrior or noble had alike returned to their parent earth, leaving no trace behind, save the enamels of her teeth and traces of his hair alone, while the ornaments they wore and took pride in, and the surroundings of their stations remained to tell their tale at this distant date. In a barrow at Tissington in which the primary (Celtic) interment was perfect, the later Saxon one had entirely disappeared, while the sword and umbone of the shield remained as they had been placed.

The mode of interment with the funeral fire, as well as the raising of the barrow, is curiously illustrated by the opening of two Saxon graves at Winster. A large wood fire had, apparently, been made upon the natural surface of the ground. In this a part of the stones to be used for covering the body, and some of the weapons of the deceased, were burned. After the fire was exhausted the body was laid on the spot where it had been kindled, the spear, sword, or what not, placed about it, and the stones which had been burnt piled over it. The soil was then heaped up to the required height.

The instances I have given (and most others which have been examined) of interment of the entire body, have occurred in the district of the Peak. In the lowlands of the county the interments appear mostly to have been by cremation, and here somewhat extensive cemeteries—either as groups of small low barrows containing interments of burnt bones—or otherwise,

have been found. In some of these the body has simply been burned, the calcined bones gathered into a small heap and then the mound raised over them. In others, and more usually, the calcined bones have been carefully collected together, placed in cinerary urns, and buried.

Two of the most extensive and remarkable cemeteries of this kind are those at Kingston and at King's Newton, both near Derby.* At the first of these places an extensive cemetery was discovered in 1844, and resulted in the exhumation of a large number of urns; indeed, so large a number, that, unfortunately, at least two hundred were totally destroyed by the workmen before the fact of the discovery became known. On the surface no indication of burials existed, but as the ground had some sixty years before been under plough cultivation, and as the mounds would originally have been very low, this is not remarkable. The urns had been placed on the ground in shallow pits or trenches. They were filled with burnt bones, and the mouth of each had been covered with a flat stone. They were, when found, close to the surface, so that the mounds could only have been slightly elevated when first formed. Of the form of the urns I shall have to speak later on.

The cemetery at King's Newton, though not so large as the one just named, was an extensive one. It was discovered during the present autumn (1867), and a large number of fragmentary urns were exhumed. The mode of interment was precisely similar to that at Kingston, and the urns were of the same character as those there discovered. There were no traces of mounds having been raised, although most probably, they had originally existed.

Cremation was the predominating practice among the Angles, including Mercia, and the modes of burning the body, and of interment of the calcined bones in ornamental urns, which I have described, in the two cemeteries just spoken of, are characteristic of that kingdom. This mode is curiously illustrated in the Anglo-Saxon poem of "Beowulf," which evidently describes the custom of the Angles. The following extract forcibly illustrates the mode of interment. The funeral pile having been raised, and hung round with shields, helmets, and coats of mail,

> ". . . the heroes, weeping,
> laid down in the midst
> the famous chieftain,
> their dear lord.

* It is a singular fact, and worthy of note, that the two most extensive Saxon cemeteries—indeed, the only two worthy the name of cemeteries—discovered in Derbyshire, are at Kingston (King's Town) and at King's Newton (King's New Town), and that at each the urns are of remarkably fine character.

> Then began on the hill
> the mightiest of funeral fires
> the warriors to awake;
> the wood smoke rose aloft,
> dark from the fire;
> noisily it went
> mingled with weeping."

The body having been burned, and the ashes collected together, the warriors and friends of the deceased raised a mound over the remains "high and broad;"

> "and they built up
> during ten days
> the beacon of the war-renowned.
> They surrounded it with a wall
> in the most honourable manner
> that wise men
> could desire.
> They put into the mound
> rings and bright gems,
> all such ornaments
> as before from the board
> the fierce minded men
> had taken."

With interments in urns, but few articles, either of personal ornament or otherwise, are found. With those, where the body has been placed entire in the grave, the objects are numerous, and, in some instances, are elaborate and beautiful in ornamentation. Among the articles which the Saxon grave-mounds of Derbyshire have produced are swords, knives, seaxes, spear-heads, umbones of shields, buckles, helmets, querns, drinking cups, enamels, gold, silver, and bronze articles, baskets, buckets, draughtsmen, combs, beads and necklaces, rings, ear-rings, caskets, armlets, fibulæ, articles for the chatelaine, pottery, etc. Of some of these I will now proceed to speak.

The sword of the Anglo-Saxon period, as evidenced by the Derbyshire barrows, is of the form shown on the accompanying engraving, from a barrow at Tissington. This sword, which is thirty-four inches in length, and two and a half inches in breadth, is, of course, of iron. It had been originally enclosed in a wooden scabbard, or sheath, which had, apparently, been covered with leather, and mounted with elaborately ornamented silver. The chape, which was of silver, was simply rounded, and

the rivets which attached it, as also those which attached the leather, remained. Another fine example was found at Brushfield, by the side of the body shown on page 460. It, too, had been enclosed in a sheath of wood, which had been covered with leather, ornamented with lines and lozenges.

The shield was usually placed in Saxon interments over the middle of the body, as indicated in the plan on page 460; but of this, indications only were in this instance found. In the Tissington barrow before spoken of, a portion of the edge of the shield was found adhering to the sword, as shown in the engraving, and the umbone, or central boss of the shield was also found. This umbone, here engraved is of iron, conical in form, and measures nine inches in height. It is the largest yet found in Derbyshire, and is in form similar to examples found at Sibertswold, and in other localities. When found, the umbone was surrounded with a mass of decayed wood, the remains of the shield, and small fragments of corroded iron, which were, doubtless, a part of its mountings.

The knives found in the Derbyshire barrows are of the general forms. They are usually found, sometimes one and sometimes two, lying by the skeleton on the opposite side from the sword, though, in some instances, the knife and sword have been found lying side by side, as in the interment on page 460.

Spear heads also of iron are occasionally found. Two of these, lying on the right side of the head, will be seen in the engraving on page 460. They are short and socketed.

One of the most remarkable objects of the Saxon era which has been exhumed is the helmet already alluded to. This highly-interesting relic was discovered by Mr. Bateman at Benty Grange, in 1848. The barrow was of but slight elevation, and contained the remains of a body which had been laid on the natural surface of the earth, as already named. Among the articles remaining—for the body, with the exception of a portion of the hair, had entirely disappeared—was the remarkable helmet here engraved. This helmet "consists of a skeleton formed of iron bands radiating from the crown of the head, and riveted to a circle of the same metal, which encompassed the brow; from the impression on the metal it is evident that the outside was covered with plates of horn, disposed diagonally, so as to produce a herring-bone pattern.

The ends of these plates were secured beneath with strips of horn corresponding with the iron framework, and attached to it by ornamental rivets of silver, at intervals of about an inch

and a half from each other. On the bottom of the front rib, which projects so as to form a nasal, is a small silver cross (shown in the engraving), slightly ornamented round the edges

by a beaded moulding, and on the crown of the helmet is an elliptical bronze plate, supporting the figure of an animal carved in iron, with bronze eyes, now much corroded, but perfectly distinct, as the representation of a hog. There are, too, many fragments, some more or less ornamented with silver, which have been riveted to some part of the helmet in a manner not to be explained or even understood. There are also some small buckles of iron, which probably served to fasten it upon the head." The boar, which is here borne as a crest on the top of the helmet, was, it appears, according to Tacitus, borne as a charm against the dangers of war, and this custom is curiously illustrated by the poem of "Beowulf," which is thus translated:—

"They seemed a boar's form
to bear over their cheeks;
twisted with gold
variegated and hardened in the fire,
this kept the guard of life."

And again, in other parts of the poem, the following allusions occur:—

"Surrounded with lordly chains,
even as in days of yore
the weapon-smith had wrought it,
had wondrously furnished it
had set it round with the shapes of swine,
that never afterwards
brand or war-knife
might have power to bite it."

"Ah, the pile was
easy to be seen
the mail-shirt coloured with gore,
the hog of gold
the boar hard as iron."

"Then commanded he to bring in
the boar, an ornament to the head,
the helmet lofty in war,
the grey mail-coat,
the ready battle sword."*

It will be noticed in these extracts that the "mail-coat," or "mail-shirt" is twice mentioned, as well as the "helmet lofty in war." Thus the passages fully illustrate the extra-

ordinary discovery in Derbyshire, which embraced a coat of mail along with the helmet and other objects (amongst which was a curious six-pronged instrument of iron). The coat of mail consisted of a mass of chain work, the links of which were attached to each other by small rings. The links were

* *Collectanea Antiqua.*

of two kinds, "one being flat and lozenge-shaped, about an inch and a half long; the others, all of one kind, but of different lengths, varying from four to ten inches. They are simply lengths of square rod iron, with perforated ends, through which pass the rings connecting them with the diamond-shaped links. They all show the impression of cloth over a considerable part of the surface, and it is therefore no improbable conjecture that they would originally constitute a kind of quilted cuirass, by being sewn up within or upon a doublet of strong cloth." Fragments of another helmet of very similar character were found in the following year in another barrow, a few miles from the one just described.

Of fibulæ, besides some small circular examples which have been from time to time found, a magnificent one of gold was discovered some years ago in a barrow on Winster Moor. This remarkably fine fibula (page 466), was formed of gold "filagree" work, which was mounted on a silver plate. It was set with stones or paste on chequered gold foil, and measured two inches in diameter. Along with this fibula were found the following interesting articles: a cross of pure gold, ornamented, like the fibula, with "filagree" work, and having a garnet cut in facets set in its centre; a silver armlet; two glass vessels, and a number of beads. These and some other articles were all found by the sides of two cinerary urns. A remarkably fine penannular brooch of the Irish type,

of the period now under notice, was discovered in the same

neighbourhood (at Bonsall), of which I may yet take occasion to speak in the pages of THE STUDENT.

Of beads and necklaces some extremely beautiful examples have been found; of these, the necklace from the barrow at Wyaston (page 467,) will be sufficient for my present purpose. It consists of twenty-seven beads, five of which are of amber, carefully rounded into a globular shape, the largest an inch in diameter, and the remaining twenty-two are of glass or porcelain, variegated in different colours. Another necklace was formed of garnets, etc., set in gold, and was of extremely elegant pensile form.

Combs, rings, earrings, and armlets have occasionally been found, and have been of the usual forms.

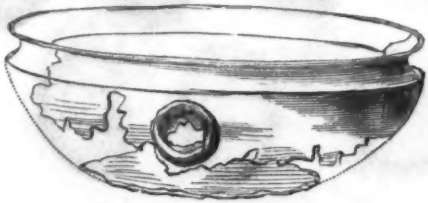
Of enamelled ornaments some choice examples have been

exhumed. One of these, a pendant ornament, was found in a

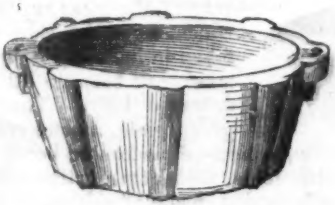
barrow on Middleton Moor, and others, though fragmentary, which are here engraved, at Benty Grange. In the same

barrow were found the silver edging and mountings, and the ornaments, of a small drinking cup of leather. The cup was about three inches in diameter at the top, and had been ornamented by two crosses and four wheel-shaped ornaments of silver, and by a silver rim and upright bands. It is shown page 468. Several other objects, in silver, including earrings, rings, sword mountings, fibulæ, and other personal ornaments, have also been brought to light. In one interment some silver ornaments, and various articles belonging to a lady's chatelainé, along with a thread box of bronze, and some bronze needles or pins, were found in what appeared to be the remains of a wicker basket. Portions of buckets too have been noticed.

In bronze many articles have been found. Among these, perhaps two of the most curious are the bowl and the small



box pierced for suspension, here shown. The bowl measured



seven inches in diameter, and the box two inches. Bosses, highly ornamented, and other bronze objects, have also been found.

One of the most curious set of objects which the Saxon graves of Derbyshire have produced is a set of twenty-eight bone counters, or draughtsmen, some of which are shown on the following engraving, where they are represented of their full size. They were found by Mr. Bateman in a barrow near Cold Eaton, along with an interment of burnt bones, some

fragments of iron, and portions of two bone combs. The draughtsmen, as they are supposed to be, and the combs had been burnt with the body. Querns have occasionally been found in Saxon barrows.

Of glass vessels I have already mentioned the finding of some examples, but it is necessary also to note the curious discovery of the glass cup here shown, and which, from the care which had been taken in inclosing it in a wooden box must have been no little prized by the deceased lady. The cup, of thick green glass, a bone comb, some small instruments of iron, a piece of perforated bone, and a necklace with pendant ornaments, with other articles, were found inclosed in a box or casket, made of ash wood half an inch in thickness, with two hinges, and a small lock, which had, when placed in the grave, been carefully wrapped in woollen cloth. The interment was in many respects a highly interesting one.

The pottery of the Anglo-Saxon grave-mounds and cemeteries consists almost entirely of cinerary urns. These were undoubtedly, like those of the ancient Britons, made near the places where the remains have been discovered, and, as a natural consequence, usually from clays found in the neighbourhood of the place. The form of the cinerary urns is somewhat peculiar. Instead of being wide at the mouth, like the Celtic

urns, they are contracted and have a kind of neck instead of the overhanging lip or rim which characterizes so much of the sepulchral pottery of that period. The urns are formed by hand, not on the wheel, like so many of the Romano-British period, and they are, as a rule, perhaps, more firmly fired than the Celtic ones. They are usually of a dark-coloured clay, sometimes nearly black, at other times they are dark brown, and occasionally of a slate or greenish tint produced by surface colouring. The general form of these interesting fictile vessels will be best understood by reference to the accompanying

engraving which exhibits two of the urns from Kingston. One of these will be seen to have projecting knobs or bosses, which have been formed by simply pressing out the pliant clay from the inside with the hand. In other examples these raised bosses take the form of ribs gradually swelling out from the bottom, till, at the top they expand into semi-egg-shaped protuberances. The ornamentation on the urns from these cemeteries usually consist of encircling incised lines in bands or otherwise, and vertical or zig-zag lines arranged in a variety of ways, and not unfrequently the knobs or protuberances of which I have just spoken. Sometimes, also, they present evident attempts at imitation of the Roman egg and tongue ornament. The marked features of the pottery of this period, is the frequency of small punctured or impressed ornaments which are introduced along with the lines or bands with very good effect. These ornaments were evidently produced by the end of a stick cut and notched across in different directions so as to produce crosses and other patterns. In some districts these vessels are ornamented with simple patterns painted upon their surface in white; but so far as my knowledge goes, no ex-

amples of this kind have as yet been found in Derbyshire. One or two examples of domestic vessels, though but in fragments, have been found in the cemeteries; but of these just now it will be unnecessary to speak. Those who desire more extended information on the subject of the pottery of the Anglo-Saxons cannot do better than turn to the sixth volume of the INTELLECTUAL OBSERVER, where they will find an admirable paper on the subject from the pen of my friend Thomas Wright, who, along with another valued friend, Charles Roach Smith, was among the first to clear up the mystery which surrounded the remains of the fictile arts of that people.

Having now fulfilled the promise which I made in the opening of this series of papers, that of devoting them to giving a general insight into the modes of construction and the contents of the grave-mounds of Derbyshire, I close my subject with the earnest expression of a hope that the information which I have given, brief though it necessarily is, may be of service to the readers of the INTELLECTUAL OBSERVER, and may enable them to appropriate to their respective ages such remains of the early inhabitants of our country as may come under their notice. In future volumes of THE STUDENT* I hope to give from time to time some short separate papers on matters to which I have so far but passingly alluded.

* See Notice on page 401.

PROGRESS OF INVENTION.

IMPROVEMENT OF DAVY'S LAMP.—Many improvements of this most valuable apparatus have been invented: one, very recently proposed, consists in the application of an outer cylindrical case, which is made, in part, of glass, and in part, of wire gauze. Both cases have independent fastenings, and therefore are not likely to be opened by any accident, nor, in ordinary circumstances, can they be opened even by design. Experiments made with this lamp have shown that it is much more to be relied upon than the ordinary kind: since it remains perfectly cool, in an atmosphere in which an ordinary Davy's lamp would be very soon heated to redness.

STEAM BOILER INCRUSTATIONS.—These, a prolific source of steam-boiler explosions, consists of earthy substances, that are bad conductors of heat, and therefore they permit the boiler, notwithstanding the proximity of water, to be unduly heated: the consequence of which is, that the metal of which it consists is burned, and greatly deteriorated in strength, or the earthy coating cracks, and allowing the water to come in contact with the highly heated metal, a vast quantity of steam is suddenly formed, or the water is even decomposed. The steam in one case, and the gas in the other, gives rise to such a pressure as the boiler may be unable to bear. The prevention of incrustration, besides removing a serious source of danger, would have the effect of economising fuel, by leaving the capacity of the metal for transmitting heat to the boiler unimpaired. One method of preventing incrustrations, is the removal of the earthy matters from the water before it is introduced in the boiler; this is difficult, and from circumstances often impossible. Another method, is to render the earthy matters harmless, by keeping them in a pulverulent state, and suspended in the water. An improvement on this method consists in arranging a number of small thin plates within the boiler, in such a way as that they over-lap, like the tiles on a roof, and form a thin space between themselves and the walls of the boiler. The heat being imparted directly to the water contained in this space, such a circulation is produced, that any deposit of sediment on the boiler is impossible. The sediment is, however, deposited on the plates; but, not being there exposed to a high temperature, it has no tendency to become a compact mass. This arrangement is attended with another advantage—the uniform and comparatively quiet disengagement of the steam: not in the lower part of boiler, but at, or near the surface of the fluid, on account of the presence of a large amount of solid particles thrown up by the circulation caused by the wall of plates.

CALORIC ENGINES.—Whether steam or heated air is used, it is only the vehicle for transmissions of the heat from the fuel to the working point, to be changed there into motion. Steam has unquestionable advantages: air has, however, persevering and plausible advocates. M. Bourget has recently introduced a modification of the caloric engine which is attracting considerable attention. He heats the air, after it has been condensed, by a system of tubes which are

placed in the flue of an ordinary furnace, and after having expanded in the cylinder, and thus actuated the piston, it is transmitted back to the heating tubes, the caloric it still retains being by this means economized. The heating power of the tubes is augmented by filling them with scraps of metal which render them magazines of heat, absorbing it when it would be in excess, on account of connection with the cylinder having being cut off during expansion, and giving it out at other times. A still better engine of this description has been invented by Mr. Wenham. It is remarkable for simplicity, economy, and compactness. The expansion of air driven through a small furnace and a very mild explosion of carbonic oxide, supplies a perfectly safe motive power.

Purification of Sulphuric acid.—Sulphuric acid, from the mode of its manufacture, is very frequently found to contain nitric acid, which though small in quantity, is difficult of separation, and if unremoved is often very inconvenient. It has been found, that sulphuric acid may be completely freed from nitric, so as to afford no indication of its presence, by means of freshly calcined and pulverized wood charcoal, which may be removed by filtration.

Production of Caloric by Magnetism.—It has been ascertained that the rapid rotations of a magnet, or what is more effective, of a compound magnet consisting of several magnetized bars, will afford caloric. The effect is due to the prevention of motion which the magnet tends to produce. The experiment may be made, by placing above the poles of a magnet, which is capable of revolving on a vertical axis with its poles upwards at the rate of fifteen or twenty times a second, a small copper plate of a circular form, and about half a millimetre thick, and putting upon this plate a flat bottomed flask of considerable capacity, and having fixed in its neck, by a cork, a tube in the form of an S with a little water in its lower curve which is within the flask; the rapid rotations of the magnet heats the air: and this expanding acts on the surface of the water in the tube and causes it to ascend. When a maximum temperature, depending on the velocity of rotation is attained, the water will remain stationary. M. Louis D'Henry, to whom this experiment is due, believes that with a sufficently powerful system of magnets, and a rapid rotation, water in a copper vessel, placed on the copper plate might be made to boil.

New Substitute for Phosphorus in the Manufacture of Lucifer Matches.—The terrible effects produced by ordinary phosphorus on those who manufacture matches with it, and the obstacles to the introduction generally of amorphorus phosphorus renders a substitute for this pernicious material very desirable. Such a substitute is most probably to be found in a mixture recently discovered by M. Böttger. It consists of eight parts trioxide of thallium, and one part penta-sulphuret of antimony: and may be ignited by friction.

Utilization of the Residues of the Smelting Furnace.—Large quantities of cinders, hitherto incapable of use for any industrial purpose are produced by smelting furnaces. They have been found on examination to consist for the most part of very minute globules of iron. The recovery of this iron will not only be a means of get-

ting rid of very large quantities of very troublesome material, but a source of considerable profit.

NEW MODE OF MANŒUVERING A VESSEL.—Floating batteries are being constructed for the protection of the coasts of Sweden. They are provided with a turret: and as the turret does not revolve, in order to secure the power of aiming the gun it contains in all directions, it is necessary that the vessel itself should rapidly turn round. This is effected with ease and certainty, by means of a paddle wheel fixed at the bow, and turning on an axis which is parallel to the length of the vessel. This wheel is entirely immersed and therefore if constructed in the ordinary way with fixed floats, it would produce no motion, the floats on opposite sides neutralzing each other. It is therefore so arranged that the floats, when in a higher position feather, and move through the water horizontally so as to have no effect in producing motion. The floats which are at the time in a lower position produce a maximum effect. This paddle wheel offered little resistance to the progressive motion of the floating battery as the floats are made of thin sheet iron: and they present their edges to the direction in which the vessel is moved. Such an arrangement would however not be suitable with other than vessels intended to remain constantly at or very near the same place.

PRODUCTION OF DETONATING POWDER, WITH THE MATERIALS OF ORDINARY GUNPOWDER.—It has been found that the rapidity of combustion of gunpowder depends greatly on the nature of the charcoal employed; the development of this fact has been carried so far, by a suitable selection of the charcoal, that the combustion becomes so rapid as to be an explosion of the unconfined powder. This is effected by the use of carbon obtained from rice starch, the albumen of blood, or leather. With nitrate of potash such carbon forms not ordinary gunpowder but a detonating material.

LITERARY NOTICES.

SUN VIEWS OF THE EARTH; OR, THE SEASONS ILLUSTRATED. Comprising Forty-eight Views of the Earth as supposed to be seen from the Sun at different Hours and Seasons. With five enlarged Sun Views of England, and a Diagram representing the Earth's daily motion in her orbit. By Richard A. Proctor, B.A., F.R.A.S., late Scholar of St. John's College, Cambridge; and of King's College, London. Author of "Saturn and its System," "The Constellation-Seasons," etc. (Longmans.)—The changes from spring to summer, autumn, and winter, depending on the positions taken up in succession by the earth in its journey round the sun, may be represented by a series of views of the earth as it might be seen from the sun at any point of the journey. The places which the sun looks straight at will receive a full share of light and heat, those which he looks at more slantingly will receive less, and those out of his reach none at all. Mr. Proctor has devised a highly instructive and pleasing set of pictures illustrating these facts, and giving a far better notion of the cause of the seasons than any diagram we have seen. Plate I. gives four coloured views of the earth at the winter solstice (Dec. 21), at 6 a.m., 6 p.m., noon, and midnight; and at a glance it is seen how the northern regions are foreshortened and the polar portions out of the sun's sight. Plate II. has similar views representing the state of things one month later, and so on in succession through spring and summer to a month before the winter solstice, represented in Plate XII. The XIIIth Plate shows on a larger scale the way in which Great Britain, France, Holland, Denmark, etc., are presented to the sun at various periods of the year. We are glad these drawings are published at a very moderate price, because they will, with the help of the explanatory letter-press, be of great use to schools and families, and to teachers who wish to know how these matters may be made most intelligible to their pupils.

We have also received from Messrs. Longman four charts drawn by Mr. Proctor: one of the Zodiac, on which, with the help of an almanack, the paths of the moon and planets may be easily traced; another of Mars representing that planet as seen from the earth at various points of his rotation. Two other charts represent the orbits of Mars, the Earth, Venus, and Mercury; and of Neptune, Uranus, Saturn, and Jupiter. A great deal of astronomical information is compressed in these diagrams, which are well worth attentive study.

HOW TO USE THE BAROMETER, 1868. By the Rev. R. Tyas, M.A. Cantab., F.M.S., Member of the Scottish Meteorological Society. Author of "Favorite Wild Flowers," etc. (Bemrose and Sons.)—The author also calls this little book "A Companion to the Weather-glass." It contains useful information about instruments, and a series of tabular forms to facilitate the registration of meteorological changes. These are very handy, though on a somewhat small scale. The author likewise does a little weather prophecying,

founded upon principles which he does not explain, but which, he asserts, have usually led to correct anticipations. He says, "Although we are unable to say positively that there will be rain in any period—say of seven or eight days—yet the probability approximates so nearly to a certainty, that we may reasonably expect rain or fair weather about the times herein stated, and this expectation leads us to watch more carefully the signs of change." Those who buy this little book may amuse themselves by testing the value of these prophecies.

PHOTOGRAPHS OF EMINENT MEDICAL MEN OF ALL COUNTRIES. With brief Analytical Notices of their Works. Edited by Wm. Tindal Robertson, M.D., M.C.P. The Photographic Portraits from Life, by Ernest Edwards, B.A. Cantab. No. 7, Vol. II. (Churchill and Sons.)—The portraits now given of this interesting series are those of Erasmus Wilson, F.R.S., Sir James Bardsley, and Dr. Thomas Hawkes Tanner. They are all good.

CLIMBING THE HILL. A Story for the Household, by the author of "A Trap to Catch a Sunbeam." (Groombridge and Sons.)—A tale by the author of so exquisite a story as "A Trap to Catch a Sunbeam," cannot fail to be welcome. The present story relates to a young couple "climbing the hill." It is gracefully told, and being published in a very handsome form, will make an appropriate new year's gift.

RAIN: HOW, WHEN, WHERE, AND WHY IT IS MEASURED. Being a Popular Account of Rainfall Investigations. With Numerous Illustrations. By G. J. Symons, F.M.S. Editor of "British Rainfall," and "Symons' Monthly Meteorological Magazine." (Stanford: Simpkin.)—This is the best book on the subject to assist in spreading a knowledge of various matters pertaining to rainfall, the methods of measuring it, and the utility of the process. Some of the tabular matter is especially interesting, such as the "Fluctuations in the Fall of Rain from 1726 to 1865," and the "Approximate mean Annual Depth of Rain at 165 Stations," in which we observe Lincoln, Southwell, and Stamford stand lowest at 20 inches, while the Stye, near Southwaite, in Cumberland, is at the head of the wet places, and shows an average of 165 inches. London stands at 24 inches, being the same as Norwich and Edinburgh. In addition to this information, we want to know the average moisture in the air, as places may have a good deal of rain distributed in heavy showers, and yet be on the average much drier than other spots where the rainfall is less, and the quantity of vapour greater. Mr. Symons points out the necessity of using the hygrometer as well as the rain-guage, and we hope that, in a few years, accurate information on the English climatology will be obtained. We agree with Mr. Symons' suggestion that local authorities should undertake the slight expense required for daily observation and records. Wind should be registered as well as rain and moisture, and so should temperature and atmospheric pressure. Magnetic and electric observations need not be so general, but should be established upon a system at public cost.

THE BOY'S OWN BOOK. A Complete Encyclopædia of Sports,

and Pastimes, Athletic, Scientific, and Recreative. A New Edition, thoroughly Revised and considerably Enlarged. (Lockwood & Co.) —We are glad to see a new edition of this book; certainly one of the best ever written for boys, and having the advantage of containing matter for boys of all ages. The new edition is a very handsome volume of nearly 700 pages, richly illustrated. It relates to all kinds of sports and pastimes, indoor and out, and mingles with cricket, archery, gymnastics, etc., directions for keeping birds, rabbits, and other domestic pets, and enough scientific recreations of various sorts to stimulate to graver studies in their proper place. It is a book we cordially recommend as a new year's gift.

On the Middle and Upper Lias of the South-West of England. By Charles Moore, F.G.S. Reprinted from the Proceedings of the Somersetshire Archæological and Natural History Society, Vol. XIII. 1865-6. (Taunton: F. May.)—A very useful monogram on the subject of which it treats, illustrated with seven nicely executed plates, containing numerous figures.

PROCEEDINGS OF LEARNED SOCIETIES.

GEOLOGICAL SOCIETY.—*Dec.* 4.

Robert Etheridge, Esq., in the chair.

Henry Alleyne Nicholson, Esq., read a paper on the Graptolites of the Skiddaw series, premising that the slates of that series corresponded with the Quebec group of Canada. He described twenty-four species.

P. Martin Duncan, Esq., M.D., described in a concluding paper the Fossil Corals of the West Indies. Dr. Duncan mentioned several curious facts in the distribution of West Indian corals, both fossil and recent, and especially the circumstance that, whilst Jamaica, San Domingo, and Guadaloupe present solitary species, mixed with those inhabiting shallow water or a reef, Antigua and Trinidad offer for consideration only reef species. In conclusion, the author drew attention to the confirmation by subsequent discoveries of his theory of an Atlantic Archipelago, which he had put forward in his earlier papers.

ROYAL MICROSCOPICAL SOCIETY.—*Dec.* 12.

James Glaisher, Esq., F.R.S., in the chair.

C. Stewart, Esq., read a paper describing the pedicellariæ of the Cidaridæ. In the discussion which ensued, Mr. Jabez Hogg stated that he had seen pedicellariæ in certain star-fish pass fragments of food from one to another towards the mouth. A Fellow remarked that Agassiz had noticed their removal of fæcal matter from the neighbourhood of the anus. Mr. Stewart said that although such

actions might have been observed in certain species, many pedicellariæ were so situated as not to be capable of performing these functions, and that their real purpose was still undecided.

H. J. Slack, Esq., Sec. R.M.S., read a paper on a microscopic ferment found in red French wine, and probably being the same as M. Pasteur's mycoderma vini, though larger than that gentleman's measurements as given in "Comptes Rendus." The mycaderm he examined consisted of minute cells, which, when the wine was poured out, rose to the surface like a fine powder. It had not turned the wine sour. He succeeded in growing the *penicillium glaucum* from it in abundance, by simply exposing the wine to the air in a tumbler. Some of the cells placed in moist sugar and water occasioned a butyric fermentation, which seemed to be caused by their decay. After a few weeks the butyric acid and other compounds of nauseous odour disappeared, and the remaining cells then increased in number, and excited a vinegar fermentation. A mixture of the wine containing the cells with treacle and water, kept in a warm place, produced *penicillium glaucum*, and the fluid became only slightly acid.

NOTES AND MEMORANDA.

Comet III., 1867.—M. Hoek, of Utrecht, writes to the "Astronomische Nachrichten" as follows:—"In my researches on cometary systems, I instanced Comets III. and V., of 1859, as probably belonging to the same system. I did not hesitate to attribute to them this character, on account of the extreme resemblance of their elements, and the short interval between their appearances. Now, all of a sudden comes a new comet to supply un unexpected confirmation of these views; for the circles which represent the planes of these three orbits cross each other at the same point in the heavens. The three planes cut each other in the same line of intersection. Thus this line is necessarily parallel to the direction of the initial movement common to the three bodies at the moment they entered into the sun's sphere of attraction." M. Hoek then gives the elements of their orbits, and states his belief that they had one common origin. Their aphelion points are situated at a considerable distance from the common point of intersection, or rather from the radiating point of their orbits. Their aphelion points are all on the same side of the line of radiation. Captain Jupman, who observed this comet at Portsmouth, in October, found it equal to a star of 8.0 or 8.1 mag., with faint coma and no tail.

New Planet (96).—This body was discovered by Dr. Luther, at Bilk-Dusseldorf, on the 23rd Nov., 1867. It appears of 10 to 11 mag.

New Stars near α Lyra.—Mr. Buckingham reports the discovery of three very minute stars near Vega. One, *c*, is in a line between the well-known B and the great star; *c* is in the same direction, on the other side of it; *d* is like *c*, near Vega, but to the left of B on the meridian. The observations were made with the large object-glasses made by Mr. Wray, one of which (new) is 21¼ inches in diameter, and, according to Mr. Buckingham's report, works well with powers up to 1800. *c* and *d*, in the large object-glass, are little brighter than the companion of Polaris, seen with an aperture of 1.7 inch. (See "Monthly Notices" for November.)

Conflagration Colours and Moonlight.—On the night of the 6th of December, the burning of Her Majesty's Theatre in the Haymarket occasioned

many curious chromatic effects. Immense flames and flame-coloured clouds of highly luminous orange and red tints made the moon (about 11 days old) look positively *blue*. Sirius, which was flashing splendidly, varied in hue from blue to deep violet.

FECUNDITY OF THE AXOLOTLS.—These curious amphibians, of which in 1864 the museum in Paris possessed five males and one female, have multiplied in captivity, so that more than 3300 have been produced from their eggs in two years and nine months. Some have been consumed in experiments, others died young, but at least 2500 have survived. Axolotls may be seen in the tanks of the Zoological Gardens.

PARALLAX OF THE SUN.—Notwithstanding the efforts hitherto made by astronomers, the exact parallax, and consequently the exact distance of the sun from the earth is not fully settled, and great interest is felt in the opportunities that may be afforded by the transit of Venus in 1874 and 1882. Meanwhile Mr. Simon Newcombe (U.S.) has been at work discussing minutely the observations of Mars in 1862. His results, communicated by M. Delaunay to the French Academy, make the solar parallax 8″.85, with a probable error of $\pm$ 0″.013. This corresponds with a distance of the sun from the earth of a little more than 23,307 terrestrial radii, rather more than 148 millions of kilometres. Taking the earth as unity, the mass of the sun will be $326{,}800 \pm 1960$, and that of the moon $\frac{1}{81.44 \pm 0.33}$. Taking the sun's mass as unity, the mass of the earth and moon together will be $\frac{1}{323{,}800}$.

ERUPTION OF VESUVIUS.—M. Pisani, writing from Resina, 13th November, 1867, says: "At half-past twelve to-night, Vesuvius has opened a new crater, to the right of the two cones of last year. At the half (*à la moitié*) of the great cone on the side of Bosco Reale, another crater has opened, pouring forth a current of lava. In the same direction, and precisely in the plane of the lava of last year, two other little craters, which cast up many streams, have been formed. The principal cone is full of crevasses, through the strong shocks it has received.

EGYPTIAN LAND SURVEYING.—The British Museum has obtained possession of a papyrus containing, in hieratic characters, a fragment of a treatise on geometry applied to land surveying, with illustrative figures. It shows how to measure squares, parallelograms, and various triangles. It is supposed to belong to the date of the twelfth dynasty, contemporary with Solomon, and it is copied from a more ancient treatise.

INDEX.

Absorption of obscure heat, 240.
Abyssinian expedition, 227.
Action of electric current on the Mimosa pudica, 145.
Action of green light on plants, 240.
Active wheel cilia, 290.
Africa, eastern coast, 229.
Agaricus, 20.
Agricultural implements found in France, 236.
Agricultural products of Abyssinia, 233.
Air columns, 46.
Air-vesicles of Bladderworts, utricularia, 207.
Alchemilla alpina, 25.
Aluminium bronze, 152.
Amiens gravel, 395.
Ammodytes tobianus, 253.
Anatomy of thysanura, 239.
Ancient ornaments, 310.
Andromeda, 379.
Anemometer, new, 392.
Anglo-Saxon remains, 459.
Animal life in Himalayas, 132.
Animal oxidation, 88.
Annelids, structure of, 266, 365.
Annuloida, 296.
Antiquarian relic at Andover, 310.
Ant's eggs, 323.
Apennines, lunar, 274.
Aphrodita aculeata, 272.
Arbroath Abbey, 26.
Archæologia. — Archæological associated bodies, 148; tumulus at Thruxton, 149; Roman pottery at Thruxton, 149; excavations at Wroxeter, 149; Roman city of Uriconium, 149; Wigmore Abbey, 150; grave-mounds of Derbyshire, 180, 254, 342, 459; Celtic period, 181; barrows, 182; sepulchral urns, 185, 344; stone cists, 186; chambered tumuli, 187; Blackmore Museum, 233; Roman lead mining, Roman work, 234; Stonehenge, 235; stones of Stenness, 235; Roman town in France, 233; agricultural implements, 236; sepulchral interments, 236; sepulchral deposits of Roman period, 236; flint implements, 254; arrow and spear-heads and dagger-blades, 254; flint knives, 256; stone implements, 256; jet articles, ancient, 257; bone implements, 258; bronze implement, 258; skeletons, 258; bronze daggers, 259; pottery, Celtic, 260, 348; cinerary urns, 260; food vessels, 260; drinking cups, 260; incense cups, 260; sepulchral urn, 261; Roman station at Vindomis, 310; Yorkshire barrows, 310; skeletons in Yorkshire, 310; bronze ornaments, 310; armlets and necklaces, 311; Roman road, 311; Roman antiquities, 311; Cheshire archæological produce, 312; flint implements, 312; Roman coins, 312; Saxon beads, 312; excavations at Wroxeter, 312; Birmingham of Roman Britain, 312; intaglio, 312; Roman coins, 313; coins of Tetricus, 313; Roman roads, 342; pigs of lead, 342; armour in tumuli, 344; ornaments in bronze, iron, and silver, 345; iron knives, 345; coins in Derbyshire, 347; beads, 348; Roman pottery, 348; Roman cemeteries, 349; Roman Salopian ware, 350.
Arctic fox, 364.
Ariadæus, second great cleft, 96.
Arid countries prevent rain, 337.
Armlets, and necklaces, 311.
Armour interred with skeletons in tumuli, 344.
Arrow and spear-heads, and dagger-blades, 254, 460.
Arthropodes, 270.
Asplanchna, 287.
Astronomy.—Notes on star streams, 1; milky way, 1; section of galactic nebula, 4; stream formations, 8; clustering in the milky way, 10; rolls of stars, 11; streams of light, 12; stippling, 12; doubts and facts concerning Linné, 36; new crater, 36; shallow crater, 37; observations on Linné, 39; Wolf on Linné, 40; Mare Vaporum and the lunar clefts, 52; cracks or rills, 52; supposition of life in Moon negatived, 55; absence of noticeable atmosphere in the Moon, 55; meteoric appearances, 80; Mars during the late opposition, 81: colours of Mars, 82; undiscovered satellite, 85; lunar clefts,

95; Mare Vaporum, 95; Ariadæus, 96; Hyginus, 98; Triesnecker, 102; Jupiter's satellites, 103; occultations, 104; Jupiter without satellites, 144; outline lunar map, 155; constitution of Sun and stars, 159; 92nd planet, 159; November shooting stars, 190; motion of rotation, 192; radiant point, 192; meteoric orbit, 196; meteoric streams, 197; Gruithuisen's city in the Moon, 214; clefts in the Moon, 215; rampart-work, 216; selenites, 217; Rhæticus, 216; hills in the Moon, 219; Jupiter's satellites, 222; occultations, 223; lunar eclipse, 223; colour of the Moon, 225: colour seen during the lunar eclipse, 226; luminous meteors, 239; lunar Eratosthenes and Copernicus, 273; Apennines, 274; zone of Eratosthenes' shadows in terrestrial sunshine, 275; lunar penumbra, 275; lava currents, 279; transit of Jupiter's satellites, 280; occultations, 280; theories of Copernicus and Ptolemy, 317; colour question and lunar eclipse, 319; two new planets, 320; coming star showers, 320; lunar details, 370; Copernicus, 370; craters in the Moon, 370; Gay Lussac, 370; light streaks, 371; crater chains, 372; Eratosthenes, 374; Sinus Æstuum, 374; double stars, 375; Lyra, 376; Cygni, 376; Andromeda, 379; clusters and nebulæ, 380; Jupiter's satellites, 381; occultations, 381; day view of Venus, 399; new planet, 479.

Atherinæ, 251.

Atmosphere in the moon, absence of, 55.

Atmospheric agency among the Cheddar rocks, 34.

Autograph of Sir Isaac Newton, 352.

Auvergne, its thermo-mineral springs, climate, and scenery, 156.

Axolotls, fecundity of, 480.

Barbets and their distribution, 241.

Badger, 202.

Baridia, 119.

Barbatula, 243.

Barks of various plants, value of, 49.

Barrows in Derbyshire, 180, 257, 342.

Bassunt bari, Indian bird, 242.

Beads, old Roman, 348.

Bee-eaters, 245.

Bell-bird, 241.

Bell rock lighthouse, 27.

Bichromate of potash and albumen, polariscope object, 240.

Bilberry and mountain or cloud berry, 25.

Belona vulgaris, 253.

Birmingham of Roman Britain, 312.

Blackmore Museum in Salisbury, 233.

Bladderworts, air vesicles of, 207.

Blasting power, new, 315.

Blood corpuscles, function of, 87.

Blood discs, 199.

Body and appendages of annelids, 267.

Bologna phosphorus, 137.

Bone implements, 258.

Botany.—Fungi on the plains of India, 18; Polyporus lucidus, 18; Schezophyllum commune, 18; Irpex flavus, 18; Dædalea sanguinea, 18; Agaricus, 18; Dum-dum collection of fungi, 18; Agaricus malleus, 20; Agaricus alliciens, 20; Agaricus holophlebius, 20; Podaxon carcenomalis, 21; Phallus truncatus, 21; ferns of Glen Clova, 23; oak fern, 23; beech ferns, 23; brittle bladder fern, 23; tooth bladder ferns, 24; Wilson's film fern, 24; holly ferns 24; hard fern, 24; Woodsia ilvensis, 24; Lastrea spinulosa, 24; Polystichum lonchitis, 24; Bilberry and mountain or cloud-berry, 25; Alchemilla alpina, 25; hart's tongue ferns, 27; sea spleenwort, 27; marsh fern, 28; green spleenwort, 29; pottery tree of Para, 50; Moquilea utilis, 50; bark of pottery tree, 50; silex in bark, 51; Handybook to collection of fungi and lichen, 79; forest trees of Himalayas, 131; orchids, 131; Magnolias, 132; Rhododendron, 132; Magnolia excelsa, 132; Rhododendron argenteum, 132; Magnolia Campbelli, 132; Gentiana coronata, 132; Foxglove, 132; Viola repens, 132; Bladderworts, 207; Utricularia vulgaris, 207; air vesicles of bladderworts, 207; utricles, 207; leaf-bearing branches, 208; gaseous evolutions in aquatic plants, 213; Hottonia, 212; Ranunculus aquatilis, 212; subjecting fruits to electricity, 399; haricot beans electrified, 399; hybrid cotton, 399; electro-capillary currents in plants, 399.

Brachion mastax, 292.

Brachions, 284.

Bradycinctus, 128.

Brama Raii, 253.

Breadth of meteoric stream, 197.

Breech-loading gun, 74.

Brimstone moth, 328.

British Association, 237.

Bronze implements, 258.

Bronze and iron ornaments, 345.

Bronze ornaments, 310.

Brown bear, 202.
Brown hair streak, 330.
Brown-tail moth, 328.
Brute Chronicle, extract, 170.
Bucconidæ, 241.
Buff tiger moth, 328.
Burying beetles' eggs, 323.
Bythocythere, 124.

Cabinet of earth unlocked, 386.
Caen stone hardening, 238.
Calcar, or spur of rotifer, 283.
Caloric engines, 473.
Candona, 118.
Canidæ family, characteristics of, 355.
Cannon, new, 392.
Cantharus griseus, 250.
Capitonidæ, 243.
Caranx trachurus, 250.
Cathedral rocks of Cheddar, 31.
Caves and coves of Forfarshire, 26.
Cave bear, 202.
Cave hyæna, 202.
Cave lion, 202.
Celtic period, 181.
Cemeteries of the Romano-British periods, 349.
Chambered tumuli, 187.
Change in position of Jupiter's satellites, 145.
Changes in appearance and position of milky way, 1.
Characteristics of rotifers, 281.
Cheddar cliffs, 30.
Chemical constituents of eggs, 324.
Chemistry.—Economic production of formic ether on large scale, 74; manufacture of steel, 74; galvanic batteries, 75; plating and gilding, 75; magnetism and diamagnetism of gases and vapours, 78; medicines through the nose, 79; functions of the blood, 86; colouring matter of blood corpuscles, 87; animal oxidation, 88; identification of blood stains, 89; poisonous action of carbonic acid gas, 89; mineralized blood, 89; test in case of suspected poisoning, 90; oxidation, 91; nutrient fluid, 92; muscular currents of electricity, 94; Bologna phosphorus, 137; prismatic colours, 138; chlorophane, or calcic fluoride, 139; luminous action of sulphide, 140; phosphorescent compounds, 140; application of superheated steam, 150; renovation of polished surface on glass, 151; application of electro-magnetism to the manufacture of iron, 151; application of sulphuret of carbon to the extraction of oleaginous matters on the larger scale, 152; utilization of aluminium bronze, 152; preservation of liquors containing alcohol, 153; new application of electricity, 153; latent image, 153; substitution of electric current for a fulminate with fire-arms, 237; absorption of obscure heat, 240; bichromate of potash and albumen, 240; novel action of light, 308; iodide of silver, 309; artificial meerschaum, 313; starch, 314; blasting powder, 315; preservative compound, 316; explosive compound, 316; photography, new application, 317; colour of water, 319; sulphuric acid formed by a mollusk, 319; micro-crystals of alkaloids, 320; hydraulic cement, 391; printing on glass, 391; galvanic battery, 393; gelatine, new application, 393; new photometer, 393; test for ozone, 399; free sulphuric acid in molluska, 399; electricity and vegetation, 399; electro-capillary currents in plants, 400; sulphuric acid, 474.
Chladni's figures, 47.
Chlorophane or calcic fluoride, 139.
Ciliary organs of rotifers, 289.
Cinerary urns, 260.
Circles of stones at Stonehenge, 235.
Clefts, lunar, 52.
Clefts in the moon, 215.
Clouds, of what they consist, 333.
Clupeidæ, 110, 250.
Clupea pilchardus, 253.
Clusterings in the milky way, 10.
Cluster and nebulæ, 380.
Coal-fields of Brazil, 80.
Coccus eggs, 327.
Coccus Persicæ, 326.
Cock-roach's eggs, 322.
Cod-fish tribe, 250.
Coinage of Japan, 14.
Coinage remodelled by Sir Isaac Newton, 351.
Coinage standard, 297.
Coins found in Derbyshire, 347.
Coins, Roman, 313.
Coleopterous insects eggs, 322.
Colour of Mars, 82.
Colour of the moon, 225.
Colours of the stars, 315.
Colour of water, 319.
Colour question and lunar eclipse, Sept. 13, 319.
Colours seen during the lunar eclipse, Sept. 13, with remarks on the preceding communication, 226.
Coloured utricles, 210.
Colouring matter of blood corpuscles, 87.
Comber fish, 250.

Combination of horse and steam power for locomotives on ordinary roads, 151.
Comet III., 1867, 479.
Component parts of Para pottery bark, 51.
Conchoecia, 128.
Conchoeciadæ, 115, 128.
Condensation of vapour, 333.
Configuration of galactic nebula, 6.
Conochilus, 284.
Constellation Lyra, 376.
Constellation-seasons, 78.
Constitution of sun and stars, 159.
Contour and elevation of a country affecting the quantity of rain, 336.
Copernican theory, 318.
Copernicus, 370.
Copernicus, lunar, 274.
Cosmical origin of shooting stars, 191.
Cosmopolites of India, 18.
Court of Exchequer, 297.
Craters in the moon, 370.
Crawling rotifers, 284.
Cremation, 184, 344.
Cross-fox fur, 358.
Crustacea, 113.
Cry of the barbet, 242.
Crustacean fauna of the English lakes, 417.
Cuirassiers rotifers, 288.
Curassones, 245.
Curiosities of sound, 42.
Curious conformation of cliff architecture, 32.
Currency system of Japan, 17.
Cuticle of the fish, 248.
Cygni, 376.
Cylindroleberis, 127.
Cypridæ, 114,
Cypridinidæ, 115, 127.
Cyridopsis, 117.
Cythere, 120.
Cytherella, 129.
Cytherellidæ, 116, 129.
Cytherideæ, 114, 120, 122.
Cytherideis, 125.
Cytheropsis, 122.
Cytheropteron, 124.
Cytherura, 124.

Dagger-blades in Derbyshire, 254.
Dark tracts near Sinus Æstuum, 375.
Darwinian theory of the transmutation of species, 384.
Davy's Lamp, 473.
Day view of Venus with small telescope, 399.
Debra Tabor, Abyssinia, 231.
Derbyshire grave-mounds, 180, 254, 342, 459.
Difference in the quality of the flesh of a sea and fresh-water salmon, 109.
Digestive apparatus of rotifers, 294.
Digestive organs of annelids, 271.
Dingy shears moth, 328,
Discoveries of antiquities in Great Britain, 201.
Double stars, 375.
Doubts and facts concerning Linné, 36.
Drawings of Mars, as seen through a telescope, 81.
Dress in olden times, 169.
Drinking cups, 260.
Dujardin's free swimmers, 287.
Dum-dum collection of fungi, 18.

Earth-borer, 323.
Eccentricity of the earth's orbit, 62.
Echoes, 44.
Economic production of formic ether on the large scale, 74.
Effect of temperature on metallic bodies, 300.
Efforts of human agency in modifying the earth's surface, 66.
Egg membrane or shell, 325.
Eggs of epiornis, 240.
Eggs of insects, 32.
Eggs of rotifers, 283.
Egyptian land surveying, 480.
Electric condition of different parts of the earth, 154.
Electric current, action on sensitive plant, 146.
Electrical countries, and their action on the weather, 134, 411.
Electricity and vegetation, 399.
Electricity, application of, to sensitive plants, 147.
Electricity, new application of, 153.
Electro-capillary current in plants, 400.
Electro-magnetism applied to manufacture of iron, 151.
Emerald volute moth, 329.
Entomology.—Insects' eggs, their structure, variety, and beauty, 321; Lepidopterous, 321; care of insects in depositing eggs, 321; cockroaches' eggs, 322; ant eggs, 322; queen bees' eggs, 322; silkworms' eggs, 322; goat moths' eggs, 322; Coleopterous insects' eggs, 322; burying beetles' eggs, 322; Scarabœida, 323; earth borer, 323; formation of eggs, chemical constituent of eggs, 324; egg membrane shell, 325; Coccus persicæ, 326; Phryganea eggs, 326; coccus eggs, 327; ova of crustaceans, 327; mottle umber moth, 327; magpie moths, 327: thorn moth, 327; strawbelle moth, 328;

dingy shears moth, 328; puss moth eggs, 328; swallow prominent moth, 328; brimstone moth, 328; lappet moth, 328; buff tiger moth, 328; brown-tail moth, 328; emerald volute, 328; glory of Kent moth, 329; silkworm moth, 329; silver lines moth, 329; meadow brown butterfly, 329; white butterfly, 330; brown hair streak butterfly, 330; termites, or white ants in India, 381; winged ants, 382; white ant destroyers, 382.
Entomostraca, 110.
Epiornis, great bird of Madagascar, 240.
Eratosthenes, lunar, 273.
Eratosthenes, region of, 374.
Ermine, 202.
Esox lucius, 253.
Eulogium historidrum, 169, 171.
Euplectella speciosa, 161.
Excavations at Wroxeter, 149, 312.
Experiments with the rigid spectroscope, 158.
Explosive compound, 316.
Eyes of rotifers, 283.

Falcons, 245.
Fall of Aerolites in Algiers, 160.
Ferns of Forfar, 27.
Ferns of Glen Clova, 22.
Finhaven fort, 28.
Fish scales, structure, etc., 246.
Five wells tumulus, 188.
Fixed rotifers, 284.
Flint cores and arrow heads, 203.
Flint flakes, 202.
Flint implements, 312.
Flint implements in Derbyshire, 254.
Flint knives, or scrapers, 256.
Flint Jack, 254.
Floscularians, 284.
Food of the salmon, 104.
Food vessels, 260.
Foraminifera, 112.
Forces called into action for a downfall of rain, 331.
Forests, great generators of rain, 337.
Forests of the Himalayas, 132.
Forgeries, Newton, 400.
Formation of eggs, 323.
Formic ether, production of, 74.
Foscules, 293.
Fossilized carapaces, 110.
Fox, fossil, 202.
Foxes, fur-bearing, 354.
Free sulphuric acid in molluska, 399.
Frogs and toads, 108.
Functions of the blood, 86.
Fungi of the plains of India, 18.
Furcularians, rotifers, 288.
Fur of grey fox, 360.
Fur of kitt fox, 360.

Gadoid fish, 247.
Gadus fish, 253.
Galileo on the milky way, 3.
Galvanic batteries, 75.
Galvanic battery, simplification of, 393.
Gaseous evolutions in aquatic plants, 213.
Gauge for steam boilers, 394.
Gelatine, new application of, 393.
Geographical distribution of annelids, 369.
Geological Society, 395.
Geology.—Geology of Glen Clova granite, 23; Craig Ought rocks, 23; felstone porphyry and syenite, 23; quartz, 23; crystals of hornblende, 23; magnetic iron pyrites, 24; caves of Forfar, 26; vitrified forts, 28; slate quarries, 29; redstones, 29; Cheddar cliffs, 30; atmospheric agency among the Cheddar rocks, 34; stratigraphical structure of Cheddar cliffs, 34; plane of marine denudation, 30; permian conglomerate, 30; wind cliff, 31; cathedral rock, 31; curious conformation of cliff architecture, 31; screes at Cheddar, 32; Cheddar caves, 33; water-mark in Cheddar caves, 33; clean removal of rock, the origin of Cheddar cliffs, 34; seamarks in Cheddar ravine, 36; geological eras, 63; coal-fields of Brazil, 80; volcanic eruptions at Santorin, 142; basalt, quartz-pebbles, argillaceous slate, jasper, schist, sandstone, 256; mining districts of Derbyshire, 342; cabinet of earth unlocked, 386; Introductory Text-book of Geology, 390; Amiens gravel, 395; Geological Society, 395, 478; chalk, 396; quaternary deposits, 396.
Geology, Introductory Text-book, 390.
Germinal matter and the contact theory, 388.
Gilding and plating, 75.
Gizzards of rotifers, 291.
Glen Clova, geology of, 22.
Globules with pedicels, 209.
Glory of Kent moth, 329.
Glycerians, 272.
Goat moth's eggs, 322.
Graduate logic-chopping, 385.
Grave-mounds of Derbyshire, and their contents, 180, 254, 342, 459.
Great cleft, lunar, 95.
Grey fox, 355.
Grun cave, 27.
Gruithuisen's city in the moon,

Jupiter's satellites, occultations, 214.
Gruithuisen's discoveries, 373.
Gulf-stream affecting rain in England, 338.
Guy Lussac, lunar crater, 370.
Gymnobucco, 243.

Habits of trachyphoni, 243.
Handbook of the history of philosophy, 386.
Hard ferns, 24.
Hardwick's drawings of fungi, 18.
Henry VIII., laws about dress, 178.
Herrings, 106.
Herring and pilchard, 248.
Herschel on the milky way, 4.
Hesione, 269.
Hills in the moon, 219.
Himalayas, April climb, 131.
Hoards of Roman coins, 313.
Horn-bills, 245.
Holly ferns, 24.
Honey guides, 245.
Horological machines, improvement in, 76.
Horse and bison, 206.
Hudson's Bay Company's sale of furs, 356.
Humming birds, 245.
Hybrid cotton, 399.
Hydraulic cement, new, 391.
Hyginus, 99.
Hyænas, 204.

Identification of blood stains, new and valuable means, 89.
Igneous rocks in Scotland, 238.
Ilyobates, 122.
Imperial mint, new, for Japan, 17.
Incense cups, 260.
Indian ants, 381.
Indian fungi, 18.
Influence of the seasons on rain, 337.
Inhumation, 181.
Insects' eggs, their structure, variety, and beauty, 321.
Intaglio found at Wroxeter, 312.
Intellectual Observer and "The Student," 401.
Intensity of sound, 43.
Intercommunication with the Japanese, 13.
Interment of the Romano-British period, 344.
Intestinal worms, 106.
Iodide of silver, coloured, 309.
Irish elk, 202.
Iron knives, 345.
Irritability of plants, 146.
Isaac Newton, 350.
Itacume of Japan, 15.

Itjib of Japan, 16.
Itzebus of Japan, 15.

Japan and its currency, 13.
Jet articles, ancient, 257.
Jupiter's satellites, 103, 222, 280.
Jupiter without satellites, 144.

Kaimeni Islands, 142.
Kent's Hole excavations, 202.
Kolangs of Japan, 15.
Koodon-felassy, Abyssinia, 231.

Labridæ, 251.
Labrus balanus, 252.
Lacinularia, 284.
Lappet moth, 328.
Largest blood discs known.—Singular capture of a Canadian reptile, Menobranchus lateralis, 199.
Latent image, 153.
Lava-currents, evident indication of, 279.
Laws in Edward IV.'s reign respecting dress, 176.
Laws which determine the relative disposition of land and water, 63.
Lead discovery, traced to funeral pyres of our forefathers, 184.
Lead mining work, Roman, 234.
Leaf-bearing branches, 208.
Limnocythere, 121.
Lepidopterous insects' eggs, 321.
Leporides, 80.
Light, novel action of, 308.
Light streaks relating to Copernicus, 371.
Light and vegetation, 399.
Linné, observations on, 39.
Links of Forth, 26.
Limnias, 285.
Literary Notices, 78, 155, 317, 384, 476.
Livingstone's fate, 396.
Localities in which rotifers are found, 295.
Loch Brandy, 25.
Lœmodon, 243.
Loxoconcha, 123.
Luminous action of phosphori, 140.
Luminous meteors, 239.
Lunar Apennines, 274.
Lunar cracks or rills, 52.
Lunar craters, 370.
Lunar clefts, Mare Vaporum, Jupiter's satellites, occultations, 95.
Lunar details, double stars, clusters and nebulæ, transits of satellites, occultations, 370.
Lunar eclipse of September 13th, 223.
Lunar Eratosthenes and Copernicus, Jupiter's satellites, occultations, 273.
Lunar penumbra, 275.

Magnetism and diamagnetism of gases and vapours, 78.
Magnetism and the meteorites, 315.
Magnolias and rhododendrons of the Himalayas, 132.
Magpie moth, 327.
Mammalia, pre-historic, 403.
Mammoth, remains of, 201.
Man, and the pleistocene mammals of Great Britain, 201.
Manufacture of starch, 314.
Mare Vaporum and the lunar clefts, occultations, 52.
Mars during the late opposition, 81.
Mason's cave, 27.
Mastax of rotifiers, 291.
Master of the Mint, Sir Isaac Newton, 351.
May islands, displacement of, 143.
Meadow brown butterfly, 329.
Measures, standard, 297.
Mechanical science, 238.
Medicines through the nose, 79.
Meerschaum, artificial, 313.
Megalœma Asiatica, 243.
Megalorhynchus, 243.
Megrim, or scald-fish, 247.
Melicertians, 284.
Mendip hills, 30.
Menobranchus lateralis, 199.
Meteoric appearances on June 11, 80.
Meteoric orbit, 196.
Meteors in November, 190.
Meteorites and magnetism, 315.
Meteorological observations at Kew observatory, 68, 302.
Metopidia acuminata, 295.
Mexican hydrology, 134.
Mexican storms, 134.
Micro-crystals of alkaloids, 320.
Microscope for waistcoat pocket, 320.
Microscope, its history, construction, and application, 388.
Microscopy, micro-crystals of alkaloid, 320; waistcoat-pocket microscope, 320; microscope, its history, construction, and application, 388; Ross's new four-inch objective, 398; cheap compressorium slide-cells, 398; microscopic ferment, 479.
Milky way, 1.
Mineralized blood, 89.
Mining districts of Derbyshire, antiquities found, 342.
Moisture, amount of, in the atmosphere, 335.
Mollusks, free sulphuric acid in, 399.
Motion of rotation, 192.
Motmots, 245.
Mottle umber moth, 327.
Mudfish from New Zealand, 399.
Mullus surmuletus, 230, 252.
Muscular force maintained by combustion of carbonaceous elements, 109.
Muscular currents of electricity, 94.
Muscular system of annelids, 271.

Natural History (including Zoology).—Native countries of different birds, 245; handy book to the collection and preparation of fresh water and marine algæ, diatoms, desmids, etc., 79; leporides, 80; food of the salmon, 104; aquatic lice, 104; voracity of the salmon, 106; herrings, 106; difference of quality in the flesh of a sea and fresh-water salmon, 109; intestinal worms, 106; river salmon, 107; frogs and toads, 108; Clupeidæ, 110; synopsis of the recent British Ostracoda, 110; entomostraca, 110; fossiled carapaces, 110; Rhizopoda, 111; fossiliferous strata, 111; foraminifera, 111; crustacea, 113; Cypridæ, 114; Cytheridæ, 114; Cypridinidæ, 115, 127; Conchoeciadæ, 115; Polycopidæ, 116, 129; Cytherillidæ, 116, 129: Cypridæ, 116; Cyridopsis, 117; Paracypris, 118; Notodromas, 118; Candona, 118; Pontocypris, 118; Bairdia, 119; Macrocypris, 119; Cytheridæ, 120; Cythere, 120; Limnocythere, 121; Cytherides, 122; Cytheropsis, 122; Ilyobates, 123; Loxoconcha, 123; Xestoleberis, 123; Cytherura, 124; Cytheropteron, 124; Bythocythere, 124; Pseudocythere, 125; Cytheridis, 125; Scerochilus, 166; Paradoxostoma, 126; Philomedes, 127; Cylindroleberis, 127; Bradycinetus, 128; Conchoecia, 128; Polycope, 129; Cytherella, 129; animal life in Himalayas, 132; birds of the Himalayas, 133; Venus' flower basket, Euplectella speciosa, 161; sponges, 161; network of skeleton of Euplectella speciosa, 163; spicules, 164; Menobranchus lateralis, 199; mammoth, 201; mammals, remains of, found, 201; Salsburg mammalia, 201; sabre-toothed animal, 201: teeth of mammalia, 201; cave lion, cave hyæna, wolf-fox, ermine, badger, cave bear, brown bear, otter, urus, Irish elk, stag-reindeer, wild boar, tailless hare, water rat, hippopotamus major, rhinoceros tichorhinus, Arvicola pratensis, Arvicola agrestis, hare, and rabbit, 202; horse and bison, 206; Epiornis, great bird of Madagascar, 240; poisonous fish, 240; barbets and their distribution, 241; bell-bird,

241; zygodactyle birds, 241; Bucconidæ, 241; blue-cheeked barbet, 241; blue-throated barbet, 242; cry of the barbet, 242; Bassunt Bari, 242; "old woman of spring," 242; nest of barbet, 242; African barbets, 243; trachyphonic barbet, 243; habits of trachyforms, 243; American barbets, 244; native country of different birds, 245; Pselopogon, 243; Megatorhynchus, 243; Megatœma Asiatica, 243; Barbatula, 243; gymnobucco, 243; Lamodon, 243; Capitonidæ, 243; Pogonorynchi, 243; Barbatulæ, 243; Trachyphonus margaritatus, 244; humming-birds, 245; toucans, motmots, puff birds, Curassows tinamous, 245; bee-eaters, hornbills, rollers, sugar birds, honey guides, orioles, 245; falcons, owls, swifts, swallows, and thrushes, 245; parrots and trogons, 245; structure and manner of growth of scales of fish, 246; reptiles scales, 246; gadoid fish, 247; megrim, or scale fish, 247; herring and pilchard, 248; cuticle of the fish, 248; sea bream, Pagellus, Centrodontus, 249; perch scales, 249; sole scales, 249; Sciœnæ, 249; Perca fluviatilis, 249; Solea vulgaris, 249; comber fish, 250; Serranus cabrilla, 250; Mullus surmuletus, 239; Trigla piper, 250; Rhombus hirtus, 250; shad, 250; Clupeidæ, 250; Cantharus griseus, 250; Caranx trachurus, 250; Scomber esiox, 250; scad, 250; Labridæ, 251; Atherine, 251; Atherina presbuta, 251; scales of lateral line, 251; Trigla cuculus, 252; Ammodytes Tobianus, 252; Labrus balanus, 252; Mullus surmuletus, 252; Pagellus centrodontus, 252; Clupea pilchardus, 253; Esox lucius, 253; Belona vulgaris, 253; Salmo trutta, 253; Brama Rait, 253; gadus fish, 253; structure of annelids, with a criticism on Quatrefages, 266; regions of the body and appendages, 267; feet of annelids, 269; hesions, 269; teguments and muscular apparatus, 269; Arthropodes, 270; muscular system, 271; digestive organs, 271; perivisceral circulatory system of annelids, 272; Aphroditians, 272; Glycerians, 272; Terebella, 272; Aphrodita aculeata, 272; rotifers, 281; ovoviviparous generation, 282; eggs of rotifers, 283; eyes of rotifers, 283; calcar or spur of rotifer, 283; Systolides, 284; fixed rotifers, 284; swimming rotifers, crawling rotifers, 284; Floscularians, 284; Melicertians, 284; Brachions, 284; Philodines, 284; Polyarthra, 284; Triarthra, 284; Conochilus, 284; Lacinularia, 284; Œcistes, 284; Limnias, 285; Stephanoceros, 286; tube-dwelling rotifers, 286; Dujardin's free-swimmers, 287; Asplanchna, 287; pitcher rotifer, 288; Salpina, 288; Pterodina, 288; cuirassiers, 288; trochal disks, 288; ciliary organs, 289; active wheel cilia, 290; gizzards, 291; mastax, 291; ciliary movement, 290; brachion mastax, 292; fœcules, 293; stomach and intestines, 293; digestive apparatus, 294; nervous system, 295; Metopidia acuminata, 295; localities in which rotifers are found, 295; Annuloida, 296; true-jointed limbs of rotifers, 296; sulphuric acid formed by a mollusk, 319; insects eggs, their structure, beauty, and variety, 321; Lepidopterous, 321; care of insects in depositing eggs, 321; cockroach's eggs, 322; ants' eggs, 322; queen bees' eggs, 322; silkworms' eggs, 322; goat moth's eggs, 322; coleopterous insects' eggs, 322; burying beetles' eggs, 323; Scarabæidæ, 323; earth borer, 323; formation of eggs, 323; chemical constituents of eggs, 324; egg membrane or shell, 325; Cocous Persicæ, 326; phryganea eggs, 326; coccus eggs, 327; ova of crustaceans, 327; mottle umber moth, 327; magpie moth, 327; thorn moth eggs, 327; straw-belle moth eggs, 328; dingy shears moth eggs, 328; puss moth eggs, 328; swallow prominent eggs, 328; brimstone moth eggs, 328; lappet moth, 328; buff tiger moth, 328; brown-tail moth, 328; emerald volute moth, 329; glory of Kent moth, 329; silkworm moth, 329; silver line moth, 329; meadow brown butterfly, 329; white butterfly, 330; brown hair-streak butterfly, 330; fur-bearing foxes, 354; Canidæ family, characteristics of, 355; red fox, 355; grey fox, 355; wolves and foxes, 355; foxes' tails, 355; South American foxes, 356; silver fox, 356; prices of fox skins, 357: cross-fox fur, 358; red fox, 358; trapping foxes, 359; red trappers, 359; kitt fox, 359; Rocky Mountain fox, 360; skull of kitt fox, 361: corsac fox, 361; thievish propensities of kitt fox, 362; Arctic fox, 364; white fox, 361; blue Arctic fox 364; respiratory apparatus of

annelids, 365; reproductive apparatus of annelids, 368; classification of annelids, 369; termites, or white ants of India, 381; winged ants, 382; destroyers of white ants, 382; skipping frog, 383; mollusks, 399; new mudfish, 399; walrus, 400.
Neptune grotto, 79.
Nerve terminations of annelids, 368.
Nervous system of rotifers, 295.
Nervous system of annelids, 367.
New crater Linné, 36.
New islands in Kaimeno group, 143.
New planets, 320.
Newton forgeries, 239, 400.
Newton, Sir Isaac, 350.
Newtonian theory of light, 139
New Zealand mudfish, 399.
Notes on star-streams, 1.
Notodromas, 118.
Notommata aurita, 288.
Novel action of light, 308.
November shooting stars, 190.
Nutrient fluid, 92.

Oak and beech ferns, 24.
Occultations, 60, 104, 223, 280, 381, 445.
Œcistes, 284.
Old red sandstone cliffs of Forfarshire, 27.
Old woman of spring, Indian bird, 242.
Oleaginous matter extracted by means of application of sulphuret of carbon, 152.
Optical purposes, a new glass, 77.
Organic philosophy, 387.
Origin of Cheddar cliffs, 30.
Orioles, 245.
Ornaments, ancient, 310.
Ostracoda, synopsis of the recent British, 110.
Otter, 202.
Outline lunar map, 155.
Ova of crustaceans, 327.
Ovoviviparous generation, 282.
Owls, 245.
Oxidation, how affected, 90.
Ozone test, 399.

Pagellus centrodontus, 249, 252.
Paracypris, 118.
Paradoxostoma, 126.
Parallax of the sun, 480.
Para pottery tree, 49.
Paris Exhibition, notes of, 425.
Parrots and trogons, 246.
Pascal and Newton, 180.
Peculiar venation, 398.
Perca fluviatilis, 249.
Perch scales, 249.
Perivisceral and circulatory system of annelids, 272.
Permian conglomerate, 39.
Phallus truncatus, 21.
Philodinea, 284.
Philomedes, 127.
Philosophical instruments at Paris Exhibition, 425.
Phosphorescent compounds, 140.
Phosphorus, substitute for, 474.
Photographic mariners' compass, 155.
Photographs of eminent medical men of all countries, 386. 477.
Photography, new application, 317.
Photometer, 393.
Phryganea eggs, 326.
Physical characteristics of the different continents, 64
Physical geography as a popular study, 61.
Pigs of lead of Roman manufacture, 342.
Pitcher rotifer, 288.
Plane of marine denudation, 30.
Planets, new, 320.
Plants, irritability of, 146.
Plating and gilding improvements, 75.
Pleistocene mammals of Great Britain, 201.
Pliocene animal, 202.
Podaxon carcinomalis, 21.
Pogonorynche, 243.
Poisonous action of carbonic acid gas, 89.
Poisonous fish, 240.
Polariscope object, 240.
Polycopidæ, 116, 129.
Polyarthra, 284.
Pontocypris, 118.
Pottery in Celtic grave-mounds, 260, 348.
Pottery tree of Para, 49.
Pre-historic mammalia, 403.
Preservative compound, 316.
Preservation of liquors containing alcohol, 153.
Pretty experiment with water, 160.
Printing on glass, 391.
Prismatic colours exhibited by phosphorus, 138. [478.
Proceedings of learned societies, 395,
Process of production of rain, 333.
Progress of invention, 74, 150, 237, 313, 391, 473.
Pseudocythere, 125.
Psilopogon, 243.
Pterodina rotifer, 288.
Ptolemaic theory, 318.
Puff-birds, 245.
Puss-moth, 328.

Quatrefages, criticism of, 266.
Queen bee's eggs, 322.

Radiant point, the, 192.
Railway safety switch, 314.
Rain, 321.
Rainbow phosphorescence, 137.
Rainfall, amount of, diminishes as rain-guage rises above the level of the ground, 340.
Rain falling from a clear sky, 341.
Rain-producing powers of wind, 336.
Rampart-works of Gruithuisen, 216.
Red fox, 355.
Regions of the body and appendages, 267.
Reindeer, 202.
Reliquiæ Aquitanicæ, 386.
Remains of man and animals found in Bedford, 201.
Remarks of Elie de Beaumont, 41.
Remodelling the coinage under Sir Isaac Newton, 351.
Renovation of polished surface of glass, 151.
Reproductive apparatus af annelids, 366.
Reptiles scales, 246.
Resonance, 47.
Respighi, estimation of crater Linné, 38.
Respiratory apparatus of annelids, 365.
Restennet priory, 27.
Revolutions of Jupiter's satellites, 145.
Rhæticus, 216.
Rhododendrons and magnolias of the Himalayas, 132.
Rhombus hirtus, 250.
River salmon, 107.
Roman antiquities, 311.
Roman city of Uriconium, 149.
Roman lead mining work on Mendip Hills, 234.
Roman pottery, 348.
Roman pottery at Thruxton, 149.
Roman road, 311.
Roman roads in Derbyshire, 342.
Roman Salopian ware, 350.
Roman station of Vindomis, 310.
Roman town in France, 235.
Ross's new four-inch objective, 398.
Rotifers, characteristics of, 281.
Royal Geographical Society, 396.
Royal Microscopical Society, 398, 478.

Sabre-toothed animal, 202.
Sacrificing human beings, 265.
Safety-valve improvement, 77.
Salmon, food of, 104.
Salmo trutta, 253.
Salpina, a rotifer, 288.
Salisbury mammalia, 201.
Santorin, eruptions at, 142.
Satellites, Jupiter's, 222.
Satellites, Jupiter without, 144.
Saxon glass beads, 312.
Scad, 250.
Scales of fishes, their structure and manner of growth, 246.
Scales of reptiles, 246.
Scarabœidæ, 323.
Scientific meetings, 237.
Sciœnae scales, 249.
Sclerochilus, 126.
Scomber esiox, 250.
Screes at Cheddar, 32.
Sea bream, 249.
Sea marks in Cheddar ravine, 36.
Section of galactic nebula, 4.
Selenites, 217.
Sensitive naked flames, 48.
Sepulchral deposits of Roman period, 236.
Sepulchral interments, 236.
Sepulchral urns, 185, 261, 344.
Serrannus cabrilla, 250.
Shadows in terrestrial sunshine, 275.
Silex in bark, 50.
Silkworms' eggs, 322.
Silkworm moth, 329.
Silver armillae, 345.
Singing and sensitive flames, 48.
Sinus Æstuum, 374.
Skeletons, 258.
Skeletons discovered in Derbyshire barrows, 184.
Skeletons found in Yorkshire, 310.
Slate quarries, 29.
Snow flakes, 332.
Solea vulgaris, 249.
Sole scales, 249.
Sound, curiosities of, 42.
Sound, waves, 43.
Sounds we cannot hear, 45.
South American foxes, 356.
Sponges, 161.
Spicules, 164.
St. Abb's head, 26.
Stag, 202.
Standards of weights, measures, and coinage, 297.
Starch manufacture, 314.
Stars, colours of, 315; new, 479
Star showers, 320.
Star streams, 1.
Steam applied to railway breaks, 316.
Steam-boiler incrustations, 473.
Steel, improvement in the manufacture of, 74.
Stephanoceros, 286.
Stippling of the field of light, 12.
Stirling Castle, 26.
Stomachs and intestines of rotifers, 293.
Stone avalanches of the Alps, 332.
Stone cists in Derbyshire, 186.
Stone implements, 256.
Stones of Stenness, 235.

Storm on Nevada de Toluca, 134.
Strait of Cheddar, 31.
Stratigraphical structure of Cheddar cliffs, 34.
Straw-belle moth, 328.
Stream formations, 8.
Streams and cascades of Glen Clova, 23.
Streams of light in the milky way, 12.
Structure and manner of growth of the scales of fishes, 246.
Structure of insects' eggs, 321.
Structure of the annelids, with a criticism on Quatrefages, 266, 365.
Study of costume, 167.
Substitution of an electric current for a fulminate with fire-arms, 237.
Sugar birds, 245.
Sulphuric acid formed by a mollusk, 319.
Superheated steam, improved application of, 150.
Supposition of life in the moon negatived, 55.
Swallow prominent, 328.
Swallows, 245.
Swifts, 245.
Swimming rotifers, 284.
Symon's Monthly Meteorological Magazine, 157.
Synopsis of the recent British Ostracoda, 110.
Systolides, rotifers, 284.

TEETH of mammalia, 202.
Teguments and muscular apparatus of annelids, 269.
Terebella, 272.
Termites, or white ants in India, 381.
Terrestrial climates, 63.
Test in cases of suspected poisoning, 90.
Tetricus, coins of, 313.
The 92nd planet, 159.
Theories of Copernicus and Ptolemy, 317.
Theodore II., 229.
Thickness of meteoric stream, 198.
Thorn moth, 327.
Thrushes, 245.
Tinamous, 245.
Toucans, 245.
Trachyphoni barbet, 243.
Trachyphonus margaritatus, 244.
Trade and currency of Japan, 14.
Trade winds, 339.
Transfer of the custody of standards, 297.
Transformation in coinage, 353.
Transits of Jupiter's satellites, 222, 280, 381, 444.
Transmission of musical sounds, 46.
Treatise on punctuation and on other matters relating to correct writing and printing, 79.
Triarthra, 284.
Triesnecker, region of, 103.
Trigla cuculus, 252.
Trigla piper, 250.
Tubulated syphon, 391.
Tumulus at Thruxton, 149.
Tycoon councils, 14.
Tyndall's Lectures on Sound, 42.

UNDULATING railways, 394.
Urns, 202.
Utricles, 207.
Utricularia, 207.
Utilization of woollen and other rags, 237.

VALLEY of the Somme, 395.
Vapour, causes of the condensation of, 334.
Variety of conditions and influences being essential to progress of civilization, 65.
Vegetation and electricity, 399.
Velocity of sound, 45.
Venus, day view of, 399.
Venus' flower-basket, 161.
Verification of sextants, 158.
Vesuvius, eruption of, 480.
Via Lactea, 4.
Vibrations of columns of sounds, 46.
Visit to Glen Clova, 22.
Vitrified forts, Forfar, 28.
Volcanic action, formation of, 143.
Volcanic action in the Azores, 79.
Volvaria sub-genus of Agaricus, 18.
Voracity of the salmon, 106.

WALRUS at Zoological Gardens, 400.
Water marks in Cheddar caves, 33.
Warden of the Mint, 351.
Warden of the Standards, 298.
Wave-movements of sound, 43.
Weight of Jupiter and size, 145.
Weights Standard, 297.
White ants of India, 381.
White ant destroyers, 382.
White butterfly, 330.
Wigmore Abbey, 150.
Wild boar, 202.
Wind cliff, Cheddar, 31.
Winds, differences in the, 335.
Winged ants, 382.
Wolf, 202.
Wolf on Linné, 40.
Wright on the Milky Way, 3.

XESTOLEBERIS, 123.

YORKSHIRE barrows, 310.

ZONE of Erastosthenes, 275.
Zygodactyle birds, 241.

ILLUSTRATIONS.

ILLUSTRATIONS IN COLOURS.

	PAGE
Milky Way, Northern and Southern Portions	1
Mars in Jan. and Feb., 1857	81
Euplectella Speciosa	161
Blue Cheeked Barbet	241
Insects' Eggs	321
Microscopic Crustacea	416
Fresh-water Planariæ	445

TINTED PLATES.

Pottery Tree of Para	49
Anatomy of Cyprida and Cytheridæ	121
Earth viewed from the Radiant Point of November Meteors	192
Flint Implements from Derbyshire	256
Asplanchna Brightwellii, illustrating the structure of Rotifers	288
Fac-simile of Autograph of Sir Isaac Newton	352

ENGRAVINGS ON WOOD.

Diagrams of Star Streams	4, 6
Fungi of India	18
Section of Cheddar Ravine	35
Lunar Clefts	58, 101
Network of Skeleton of Euplectella speciosa	163
Organic Juncture of Fibre	164
Furbelow of Euplectella	165
Skeletons in Derbyshire	182
Grave Mounds and Urns	183—188
Blood Discs	199
Lunar Map	218
Flint Implements	254, 255, 256
Barrow on Middleton Moor	257
Jet Ornaments in Derbyshire Barrows	257
Jet Studs	258
Bone Implements	258
Celt	259
Cinerary Urns	262, 263
Food Vessels	264
Drinking Cups	265
Incense Cups	265
Mastax of Rotifers	291
Vascular System of Notommata	294
Ornaments, Romano-British	345
Iron Knives	346
Roman Beads	348
Cinerary Urns	347, 348
Anglo-Saxon Grave	460
Anglo-Saxon Remains	463—471

HARRILD, PRINTER, LONDON.

31 (2)